U.S. Army Center for Health Promotion and Preventive Medicine

PYROTECHNICS HEALTH RISK ASSESSMENT NO. 39-EJ-1485-99 RESIDENTIAL EXPOSURE FROM INHALATION OF AIR EMISSIONS FROM THE M158 RED STAR CLUSTER SIGNAL ILLUMINATION

DEPARTMENT OF DEFENSE IDENTIFICATION CODE: L306

Prepared by:

Environmental Health Risk Assessment & Risk Communication Program
and
Ambient Air Quality Management Program

Prepared for:

U.S. Army Environmental Center

Published date:

19 June 2000

Approved for public release; distribution unlimited

USCHPPM

Readiness Thru Health

U.S. Army Center for Health Promotion and Preventive Medicine

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

★ *Integrity is the foundation*
★ *Excellence is the standard*
★ *Customer satisfaction is the focus*
★ *Its people are the most valued resource*
★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
19-06-2000	Technical Report	March 1999-May 2000

4. TITLE AND SUBTITLE
Pyrotechnics Health Risk Assessment No.39-EJ-1485-99
Residential Exposure from Inhalation of the Air Emissions from the M158 Red Star Cluster Illumination, Department of Defesnse Identification Code: L306

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Joleen Mobley, Stafford D.F.R.Coakley, Jeffrey S. Grow, P.E.

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Center for Health Promotion and Preventive Medicine
5158 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-5422

8. PERFORMING ORGANIZATION REPORT NUMBER
Risk Assessment # 39-EJ-1485-99

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Environmental Center
ATTN: SFIM-AEC-ETD
Aberdeen Proving Ground, MD 21010-5401

10. SPONSOR/MONITOR'S ACRONYM(S)
USAEC

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
SFIM-AEC-ET-CR-200043

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Unlimited:
Approved for Public Release

13. SUPPLEMENTARY NOTES
Point of Contact: Tamera Clark-Rush 410-436-6849

14. ABSTRACT
This assessment evaluated the potential for human health effects to offsite residents breathing air emissions following use of the M158 Red Star Cluster Signal Illumination during training exercises. The military uses pyrotechnics for signaling, obscuring, and illumination during training exercises to simulate battle conditions. Study results showed no protential for health risks to the hypothetical resident from inhalation of air emissions from the M158. To conduct this study, air emissions from the M158 were collected in a test chamber (at Dugway Proving Grounds, UT. This information was then used in an air dispersion model to determine ambient air concentrations at a location 100 meters (downwind from the site where the item was activated. Modeled air concentrations were combined with exposure information to estimate the amount of substances the hypothetical resident breathes. This intake was combined with the substance's health information, to determine if there is a potential for health risks from inhjalation of these substances. The health risk included both long-term and short term exposures to the modeled substance concentrations. Study results showed no potential for helath risks from inhalation of air emissions from the M158.

15. SUBJECT TERMS
pyrotechnics, emissions, dugway proving ground, bangbox

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Tamera Clark-Rush
U	U	U	UU		19b. TELEPHONE NUMBER *(Include area code)* 410-436-6849

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

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PYROTECHNICS HEALTH RISK ASSESSMENT NO. 39-EJ-1485-99 RESIDENTIAL EXPOSURE FROM INHALATION OF AIR EMISSIONS FROM THE M158 RED STAR CLUSTER SIGNAL ILLUMINATION

EXECUTIVE SUMMARY

This assessment evaluated the potential for human health effects to offsite residents breathing air emissions following use of the M158 Red Star Cluster Signal Illumination (M158) during training exercises. The military uses pyrotechnics for signaling, obscuring, and illuminating during training and combat. Pyrotechnics are also used during training exercises to simulate battle conditions. Study results showed that no adverse health impacts are expected, to the hypothetical resident, from inhalation of the air emissions from the M158.

To conduct this study, air emissions from the M158 were collected in a test chamber (Bang Box) at the Dugway Proving Ground, Utah. This information was then used in an air dispersion model to determine ambient air concentrations at a location 100 meters (328 feet) downwind from the site where the M158 was activated. Since the training facility in this study is hypothetical, the air model used assumptions that provided conservative estimates of air concentrations.

Modeled air concentrations were combined with exposure information (e.g., number of exposures per year) to estimate the amount of substances the hypothetical resident breathes. This intake was combined with the substance's health information, which was obtained from agencies such as the U.S. Environmental Protection Agency, to determine if there is a potential for health risks from inhalation of these substances.

The health risk study included both long-term (30 years) and short-term (15-minute or 1-hour) exposures to modeled substance concentrations. Study results showed no potential for health risks to the hypothetical resident from inhalation of air emissions from the M158.

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LIST OF ACRONYMS

AEC	U.S. Army Environmental Center
AEGL	Acute Exposure Guideline Levels
AIHA	American Industrial Hygiene Association
ATV	Acute Toxicity Value
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
HBSL	Health-Based Screening Level
NAAQS	National Ambient Air Quality Standards
NAC/AEGL	National Advisory Committee for Acute Exposure Guideline Levels
NEW	Net Explosive Weight
OEL	Occupational Exposure Limit
PM_{10}	Particulate Matter under 10 micrometers in size
PRG	Preliminary Remediation Goals
RBC	Risk-Based Concentration
RfC	Reference Concentration
TEEL	Temporary Emergency Exposure Limits
TPCWG	Total Petroleum Criteria Working Group
TSP	Total Suspended Particulates
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine

PYROTECHNICS HEALTH RISK ASSESSMENT
NO. 39-EJ-1485-99
RESIDENTIAL EXPOSURE FROM INHALATION OF AIR EMISSIONS FROM THE M158 RED STAR CLUSTER SIGNAL ILLUMINATION

1. PURPOSE

This document presents the evaluation of the potential for human health effects to offsite residents breathing air emissions following use of the M158 Red Star Cluster Signal Illumination (M158) during training exercises.

2. AUTHORITY

Memorandum, U.S. Army Environmental Center, 4 June 1999, Subject: Pyrotechnics Risk Assessment.

3. REFERENCES

See Appendix A.

4. BACKGROUND

a. PYROTECHNICS AND THEIR USE

The term pyrotechnic is derived from the Greek words "pyr" and "techne" meaning fire and art. The terms pyrotechnics and fireworks are often used interchangeably. Examples of pyrotechnics include distress flares and fireworks used for commercial (for public displays) and consumer (e.g., sparklers) use. Every year during New Year and Independence Day celebrations fireworks are used for public displays across the country. During the 1998 Olympic Winter games in Nagano, Japan, almost 5000 pyrotechnics were launched during a firework display that lasted 8 minutes.

The military uses pyrotechnics for four purposes: 1) as a method of communication through the use of signals, 2) to produce smoke to reduce enemy effectiveness, 3) for illuminating the field, and 4) to simulate battle conditions during training exercises. Pyrotechnics play an important role in both military training and combat. It is important that our troops are adequately trained to use them properly.

b. WHAT IS THE M158 RED STAR CLUSTER SIGNAL ILLUMINATION?

The M158 is a star cluster, which is a type of pyrotechnic device consisting of a hand-held signal rocket. The M158 produces a cluster of five red-colored, free-falling stars and used for signaling and illuminating. It is 10.16 inches long, 1.67 inches wide, and weighs 1.30 pounds (Reference 1).

c. USE OF THE M158 RED STAR CLUSTER SIGNAL ILLUMINATION

The M158 is used during many Army training events. These events are held at nearly every Army training installation. In general, one item is used during a day of training, which typically occurs five times per year. A rocket containing the signal is launched from a hand-held device. After igniting, the rocket reaches a height of about 200 feet and produces a five-star illumination resembling a firework. The stars extend to a height between 650 and 800 feet (about the height of a 65 story building) (References 2, 3). Troops use the star cluster signals to communicate with one another. The light it provides can also be used for other purposes. For example, it can provide light for nighttime ground operations or it can be used to reveal an enemy's suspected hiding place.

d. ASSESSMENT SUMMARY

The approach for this study consisted of two main parts: air dispersion modeling and exposure assessment. These are briefly discussed in the paragraphs below. Sections 5-7 present a more explicit discussion of the methodology used for this study.

Data generated in the "Bang Box" at the Dugway Proving Ground, Utah (Reference 4), were used with an atmospheric dispersion model (Reference 5) to estimate the average concentrations that would be experienced by an offsite resident. Since this study is designed to provide results that would be applicable to most Army training facilities, the training area used in this evaluation was a hypothetical one. In addition, air-modeling parameters were selected to mimic worst-case conditions.

The exposure assessment included calculations of time-averaged concentrations for both long-term (chronic) and short-term (acute) exposures. For the purpose of this study, air concentrations were averaged over 30 years for chronic exposures and 1 hour or 15 minutes for acute exposures. These concentrations were compared to chronic health-based screening levels (HBSLs) established by the U.S. Environmental Protection Agency (EPA) or acute toxicity values (ATVs) established by selected agencies depending on the exposure duration (i.e., 30 years versus 1 hour or 15 minutes). If the chronic or acute averaged concentrations ($C_{chronic}$ and C_{acute}) were greater than these screening levels, further analysis would be warranted to determine the potential for health effects. It should be noted that concentrations greater than the screening levels do not indicate an onset of health effects, but rather the potential for such.

5. METHODS AND DATA COLLECTION

a. EMISSION FACTORS

The air modeling emission rates were derived from the pyrotechnics emission studies conducted at Dugway Proving Ground, Utah (Reference 4). These studies sampled air emissions from the firing of weapons and/or munitions used in training. The purpose of this sampling was to identify and quantify the air emissions. The data provided by Dugway Proving Ground included the identification of the munitions item and compounds sampled, net explosive weight (NEW) of the item, vertical and horizontal dimensions of the plume from thermograph data and video, and compound emission factors. This data is included in the tables in Appendix B.

b. AIR MODEL

(1) BACKGROUND

Air dispersion models are available to mathematically simulate atmospheric conditions and behavior to predict downwind concentrations caused by emissions from various sources. However, specific models are not available to estimate the dispersion of emissions from the use of munitions in training. The emissions from munitions used in training result in ambient concentrations of compounds at various locations. The magnitude and location of these concentrations depend on many factors including the amount and type of emissions, the behavior of the source, and meteorological conditions. Based on the evaluation of air dispersion models for military munitions, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) recommended using the Integrated PUFF (INPUFF) model to estimate the dispersion of emissions from mobile pyrotechnics (Reference 6).

(2) DESCRIPTION

The INPUFF Model was developed to simulate dispersion from instantaneous or semi-continuous point sources. This Gaussian-integrated puff model is capable of addressing a puff type release over short periods of time, and computations can be performed for a single point source for multiple receptors. The algorithm used to calculate concentrations uses a vertically uniformed wind direction (with no chemical reaction) to compute the contribution of each puff at a receptor for each time step/interval.

(3) ASSUMPTIONS

Some assumptions were made to best represent the M158 in the air model. These assumptions were as follows:

(a) For unconventional sources with no physical stack dimensions, the initial horizontal and vertical dispersion values (σ_y and σ_z) of the released puff were used to define the dimensions of the puff. Therefore, plume rise and formation were not determined by characterizing flue gas exit velocity and stack diameter, as they are with conventional point sources. The initial dimensions were set to values measured during Dugway Proving Ground testing and the dispersion of the initial cloud was modeled. The physical dimensions, including height and length of the puff or cloud, were estimated from the thermograph data recorded at every time step. The data also included minimum, mean, and maximum temperature readings during the duration of the emission test and were used to define the flue gas exit temperature. These puffs were then modeled at different release heights as depicted in Figure 1.

(b) The worst-case release scenario analysis was performed using EPA Risk Management Program Guidance (Reference 7). This guidance includes tables for estimating the footprint of chemical releases. These guidelines were intended to inform emergency responders of the worst possible accidental release, but not necessarily the most likely. The EPA has defined most default conditions for meteorological modeling parameters. Table 1 lists the parameters that were used in the model.

TABLE 1. AIR MODEL INPUT PARAMETERS

MODEL PARAMETERS	
Number of meteorological periods (NTIME)	1
Duration of each meteorological period (ITIME)	300 s
Number of updates to the source (NSRCDS)	100 per source
Duration between each source update/time-step (ISUPDT)	3 s
Total time modeled/Simulation Period (NTIME * ITIME)	300 s
SOURCE PARAMETERS	
Source/Stack Diameter	0.5 m for sources (1-6).
Source/Stack Height	See Table 3.
Source Exit Temperature	Varied for each source every time step (3 s) degrees Kelvin (K)
Exit Velocity	NA
Emission Rate	1 g/s
Initial horizontal dispersion (σ_y)	Varied for each source every time step (3 s)
Initial vertical dispersion (σ_z)	Varied for each source every time step (3 s)

TABLE 1. AIR MODEL INPUT PARAMETERS

WORST CASE METEOROLOGICAL PARAMETERS	
Wind Speed	1 m/s
Atmospheric Stability	Category F
Wind Direction	270° degrees West
Ambient Temperature	293 degrees Kelvin (K) or 68 °F
Worst case Receptor Location	100 m directly downwind

(c) The resident used in this study was assumed to be directly downwind from the source. The meander of the puff is a major factor when estimating concentrations at given locations downwind from the source. Assuming that the resident is directly downwind from the source is the same as assuming that there is no puff meander and provides the most conservative modeled concentrations.

(d) For the purpose of this study, the number of items per event was defined as the activation of one item during a 24-hour period.

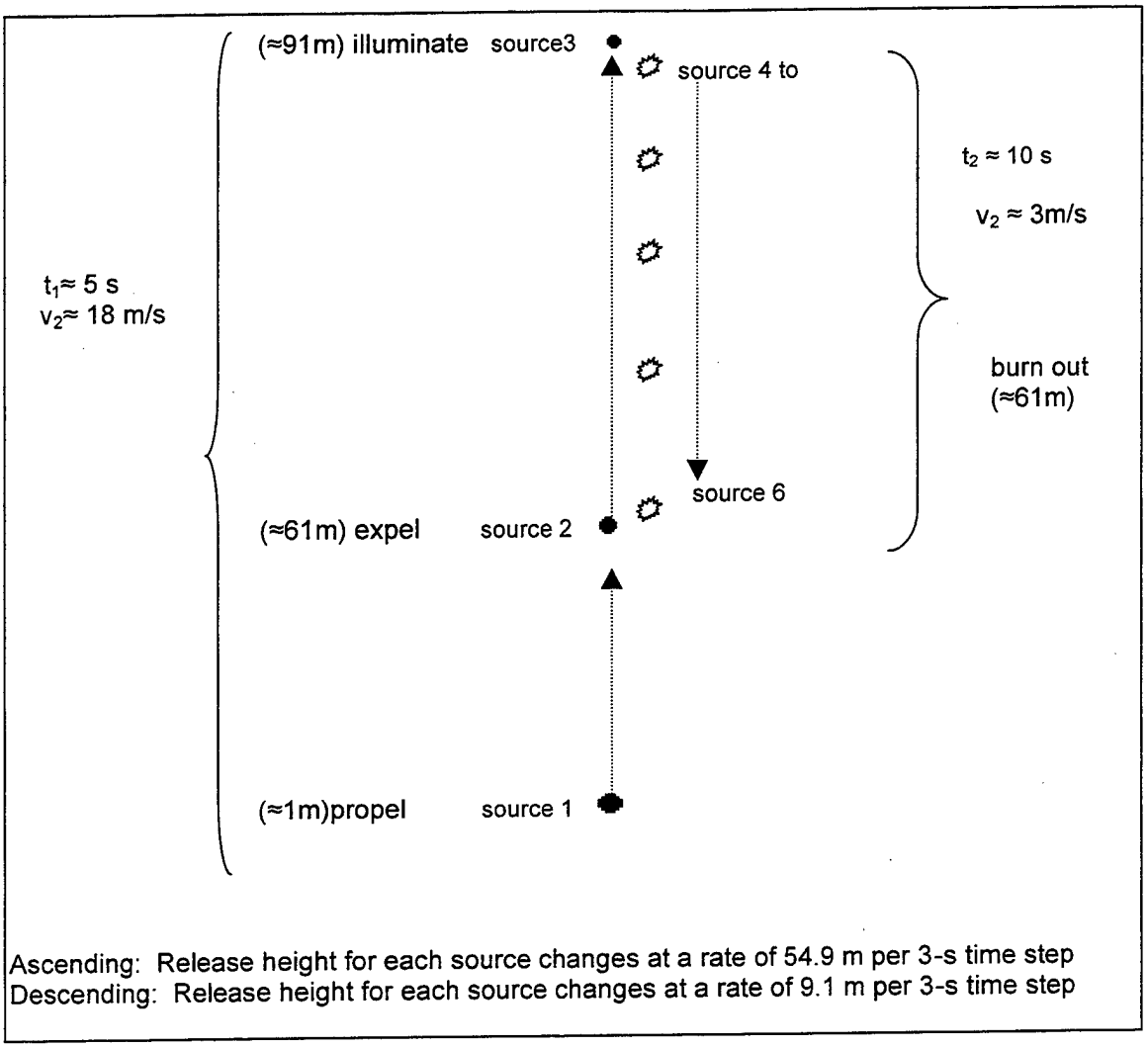
(e) Figure 1 provides a schematic diagram of the trajectory of the M158. The data for Figure 1 were obtained from References 1 and 8. The performance data provided estimated travel times (t), and velocities (v) at which the items ascend and descend.

(4) GENERAL METHODOLOGY

(a) The INPUFF model determined the amount of time it would take for the puff to pass over a location 100 meters (m) downwind. The released puff migrated at the constant wind speed of one meter per second (1 m/s) downwind from the point of activation. Assuming a distance of 100 m and a travel velocity of 1 m/s, it took 100 s for the center of each puff to reach this distance. The source was modeled at the appropriate release heights and intermediate concentrations were calculated by INPUFF at a location 100 meters downwind.

(b) The model was run with a total runtime of 300 s to ensure that the total mass of the puff had passed the receptor and the source behavior recorded in the thermograph data was sufficiently simulated. Since the model is capable of providing 100 updates (puffs), each intermediate puff was assumed to be 300 seconds (s) divided by 100 updates, which is 3 s. Calculated concentrations every time step (3 s) indicated that the puff reached the receptor within 78 s and dissipated below, the lowest concentration the model could calculate in this instance, 1×10^{-10} grams/m^3 within 135 s.

FIGURE 1: SCHEMATIC DIAGRAM OF THE TRAJECTORY OF THE M158



Ascending: Release height for each source changes at a rate of 54.9 m per 3-s time step
Descending: Release height for each source changes at a rate of 9.1 m per 3-s time step

(c) The star clusters were modeled as six different sources with different source parameters for each time step. A different release height with varying release temperatures was used for each source. Table 2 illustrates how the emissions for the M158 were separated into six different point sources and the emissions for each source were staggered over a burn time of 18 s.

TABLE 2: M158 SOURCE SIMULATION

Source No.	Height (m)	Unit Emission Rate of 1g/s per time step
1	1.0	0 to 3 s
2	56.0	3 to 6 s
3	91.0	6 to 9 s
4	82.0	9 to 12 s
5	73.0	12 to 15 s
6	64.0	15 to 18 s

* The emission rates return to 0 g/s for all time steps not shown in the table. Note: the location of each of the sources with z representing the base elevation was modeled at (x,y,z)=(0,0,0)

(5) USE OF MODEL OUTPUT

The concentrations provided by the INPUFF model are based on a unit emission rate of 1 g/s from an emission source and does not represent any pollutant-specific concentration from the use of pyrotechnics. The relationship between the emission rate and predicted concentration is linear. Therefore, the ratio of the predicted concentration to the unit emission rate was multiplied by each pollutant-specific emission rate to provide pollutant-specific concentrations.

(6) DETERMINATION OF POLLUTANT-SPECIFIC EMISSION RATES

(a) The actual emission rate per item (ER_1) for each pollutant was calculated using the following equation:

$$ER_1 = \frac{M \cdot CV}{t} \qquad \text{Equation 1}$$

where:

ER_1 = emission rate for one item (g/(item*sec))
M = total mass (lb) of pollutant emitted per item (lb/item)
CV = conversion factor (453.59 g/lb)
t = release duration in seconds (s) (References 1, 8)

Example 1
Sample Calculation Using Equation 1*:

$$ER_1 = \frac{(9.161\text{E-}02)(453.59)}{(18)}$$

= 2.309E+00 g/(s*item)

*Calculation for TSP. Averaged adjusted emission factor of total suspended particulates (TSP) in lb/item was obtained from Appendix B.

(b) The pollutant emission rate for an event (ER_{EV}) for each pollutant was calculated using the estimated number of potential items used in a training event according to the following equation:

$$ER_{EV} = ER_1 \cdot I \qquad \text{Equation 2}$$

where:

ER_{EV} = emission rate for the estimated number of potential items used in a training event (g/s)
ER_1 = emission rate for one item (g/(item*sec))
I = items per event (item/event)

Example 2
Sample Calculation Using Equation 2*:

$$ER_{EV} = (2.309E+00)(1)$$

= 2.309E+00 g/s

* Calculation for TSP

(c) Pollutant-specific ambient concentrations for an event (CONC) were calculated using the following equation:

$$CONC = ER_{EV} \cdot \frac{UC}{ER_{unit}} \qquad \text{Equation 3}$$

where:

CONC = pollutant concentration based on the number of items used in a training event (g/m^3)
ER_{EV} = emission rate for the estimated number of items used in a training event (g/s)
ER_{unit} = unit emission rate as used in the model (g/sec)
UC = concentration based on the unit emission rate (g/m^3)

Example 3
Sample Calculation Using Equation 3*:

$$CONC = (2.309E+00)\frac{(2.763E-04)}{(1)}$$

= 6.378E-04 g/m^3

* Calculation for TSP

c. EXPOSURE ASSESSMENT

(1) EXPOSURE ASSUMPTIONS

(a) Exposure assumptions were selected using a typical use scenario for the M158. This use scenario was developed based on consultation with the U.S. Army Environmental Center's (AEC) senior training advisor (References 9, 10). The frequency of use of the M158 was required to determine how much substance an offsite resident would be exposed to in the time period of interest (i.e., acute or chronic exposure). For the purposes of this study, a training scenario is defined as a day or session of training whereas a training event is defined as a single use of pyrotechnics. A training scenario may consist of multiple training events. Table 3 summarizes the specific assumptions used to determine how often the M158 is used during a training scenario.

TABLE 3: FREQUENCY OF USE FOR THE M158

Parameter	Value Used
Number of items used per training scenario	1
Number of items used per training event	1
Number of training events per scenario	1
Time between events	NA
Number of scenarios per year	5

(b) To estimate the air emissions, it was assumed that one M158 was activated. The puff that resulted from this event was modeled to a point 100 meters downwind. Since the unit emission rate was calculated using a runtime of 300 seconds, each event was also assumed to last 300 seconds (or 5 minutes).

(2) TIME-AVERAGING

For the chronic assessment, time-averaged concentrations were calculated using the EPA's default residential exposure duration of 30 years (this value assumes that the resident spends 30 years at the same residence). This was done to derive concentrations that would be consistent with the exposure duration used by the EPA so that estimated substance concentrations could be compared to their respective health-based screening levels.

In this evaluation, training scenarios occur five times a year (References 9, 10). Using the default residence time established by the EPA, the assumption was made that someone could be exposed to five training scenarios per year for 30 years.

(a) The daily averaged concentrations were calculated using Equation 4. An example calculation using cadmium is included in Example 4. It should be noted that the average modeled concentration was converted from g/m^3 to µg/m^3 before it was used in Equation 4.

$$C_d = \frac{CONC \cdot ET \cdot EF_{day}}{1440} \qquad \text{Equation 4}$$

where:

C_d = average daily concentration (µg/m^3)
$CONC$ = average modeled concentration (µg/m^3)
ET = exposure time (minutes/event)
EF_{day} = exposure frequency (events/day)
1440 = unit conversion from minutes to day

Example 4
Sample Calculation Using Equation 4:

$$C_{d(cadmium)} = \frac{(4.427E-03)(5)(1)}{1440}$$

= 1.537E-05 µg/m^3

The averaged modeled concentration (CONC) for cadmium was obtained from Appendix B. The exposure parameters were obtained from Table 4.

(b) Chronic averaged concentrations were calculated using Equation 5. The resulting concentration (C_d) from Equation 4 was used in Equation 5 to determine the averaged chronic concentrations. Example 5 shows how this calculation was performed.

$$C_{chronic} = \frac{C_d \cdot EF_{year} \cdot ED}{AT} \qquad \text{Equation 5}$$

where:

$C_{chronic}$ = average chronic concentration (µg/m^3)
C_d = average daily concentration (µg/m^3)
EF_{year} = exposure frequency (days/year)
ED = exposure duration (years)

AT = averaging time (days)
(for carcinogenic endpoint, AT = 70 years x 365 days;
noncarcinogenic endpoint, AT = ED x 365 days)

Example 5
Sample Calculation Using Equation 5:

$$C_{chronic\,(cadmium)} = \frac{(1.537E-05)(5)(30)}{(70)(365)}$$

$$= 9.024E\text{-}08\ \mu g/m^3$$

The average daily concentration was calculated as shown in Example 4. The exposure parameters were obtained from Table 4. The averaging time for cadmium is based on the carcinogenic endpoint.

(c) This study assumed that the same person would be exposed 5 days every year for 30 years. Table 4 lists the exposure parameters used in Equations 4 and 5.

TABLE 4: EXPOSURE PARAMETERS USED TO DETERMINE TIME-AVERAGED CHRONIC AIR CONCENTRATIONS

Exposure Parameter	Value Used
Exposure Time (ET)	5 minutes/event
Exposure Frequency (EF_{day})	1 event/day
Exposure Frequency (EF_{year})	5 days/year
Exposure Duration (ED)	30 years

(d) Unlike the chronic evaluation, guidance for evaluating acute exposures is not currently available. Due to the nature of the use of pyrotechnics and short duration of the concentration plume, acute exposures cannot be overlooked. For the purpose of this study, acute exposure is defined as a 1-hour or 15 minute exposure. The 1-hour or 15 minute acute exposure averaging times allow for comparison with guidelines developed specifically for emergency planning purposes (see discussion on acute toxicity below). This is a conservative assumption since the air model indicated that the hypothetical resident is not expected to be exposed for more than 5 minutes to the concentration plume following activation of the M158.

(e) The average acute concentrations were computed using Equation 6. The exposure frequency is based on the number of events per 1-hour or 15 minutes depending on the guideline used for comparison. Example 6 contains a sample calculation of this equation.

$$C_{acute} = \frac{CONC \cdot ET \cdot EF_{hour}}{60} \qquad \text{Equation 6}$$

where:

C_{acute} = average acute concentration (µg/m^3)
CONC = average modeled concentration (µg/m^3)
ET = exposure time (minutes/event)
EF_{hour} = exposure frequency (events/hour)
60 = unit conversion, 60 minutes/hour

Example 6
Sample Calculation Using Equation 6:

$$C_{acute(cadmium)} = \frac{(4.427E-03)(5)(1/0.25)}{60}$$

= 1.476E-03 µg/m^3

The average modeled concentration (CONC) for cadmium was obtained from Appendix B. Since the acute toxicity value for cadmium is based on a 15-minute exposure duration (TEEL), the acute concentration was averaged over 15 minutes so that C_{acute} can be compared with its toxicity value.

d. TOXICITY ASSESSMENT

The potential for health risks was determined by comparing time-averaged air concentrations to health-based screening levels, which are developed from a substance's known toxicity. These toxicity values typically include different levels of safety factors depending on the level of confidence of the critical study. Appendix C contains a table of screening values used for the chronic and acute evaluations.

(1) CHRONIC ASSESSMENT

(a) The chronic assessment was evaluated using a screening approach. Using this method, a substance's estimated time-averaged air concentration was compared to its HBSL. If this ratio was less than one, no further analysis was required. This approach is conservative because

the exposure assumptions used by the EPA, to establish HBSLs, assume that the resident is exposed for 350 days per year (assuming 2 weeks vacation per year). Since the training scenarios, in which the M158 is used, are not expected to exceed 5 days per year, HBSLs specific to this study (if they were developed) would likely be higher.

(b) HBSLs were obtained from the EPA, primarily from Region 3 and Region 9 (References 11, 12). To ensure that the most recent information was used, the Internet sites of both regions were checked. Although the general approach used by both Region 3 and Region 9 is the same, the exposure assumptions differ enough so that final recommended screening levels can vary to a certain degree. In both methods a substance's HBSL is selected using the toxicity endpoint that derives a lower concentration. For example, if a substance has a known systemic toxicity and is a carcinogen, concentrations were calculated using both toxicity information. The lower concentration was then selected as the recommended screening level to maintain a conservative approach.

(c) A hierarchy was developed in order to quantitatively evaluate for as many of the identified substances as possible. Since the methodology used by Region 9 results in lower HBSLs than Region 3, the Region 9 preliminary remediation goals (PRGs) were used first. Region 3's risk-based concentrations (RBCs) were only used when a PRG was not available. The only exception was for chromium (VI) [Cr (VI)] where Region 9 used a carcinogenic toxicity value that was seven times greater than the EPA's recommended value to develop its screening level for inhalation exposure (Reference 13). Since the EPA does not advocate the application of this multiplication factor, the RBC for Cr (VI) was used instead of the PRG.

(d) Some substances have neither PRGs nor RBCs because they have their own set of regulatory standards. Under the Clean Air Act, the EPA is required to establish National Ambient Air Quality Standards (NAAQS) (Reference 14) for several substances considered harmful to public health and the environment. Currently, NAAQS are available for six substances, of which carbon monoxide, nitrogen dioxide, lead, sulfur dioxide, and particulate matter < 10 micrometers (PM_{10}) have been detected in the M158 Bang Box study. The NAAQS for the longer averaging time were used for the chronic evaluation. Depending on the substance, this can range from an 8-hour average to an annual average. In addition, since the majority of the measured total suspended particulates (TSP) were PM_{10} (Reference 4), the NAAQS for PM_{10} was used to evaluate the potential for health effects from exposure to TSP.

Example 7
Sample Calculation Comparing a Substance's Estimated Chronic Concentration to Its HBSL:

$$\frac{C_{chronic\,(cadmium)}}{HBSL} = \frac{9.02E-08}{1.07E-03}$$

= 8.46E-05 <1

The HBSL used for cadmium is a PRG. In this case, the resulting ratio is five orders of magnitude less than one, indicating further evaluation is not necessary.

(e) Many petroleum hydrocarbons were detected but do not have specific screening levels. Therefore, the approach recommended by the Total Petroleum Criteria Working Group (TPHCWG) (Reference 15) was adopted to evaluate petroleum hydrocarbon mixtures. Based on the working group's assessment of various hydrocarbons, they recommended that mixtures be separated according to a substance's number of carbons and its chemical class (i.e., aliphatic or aromatic[1]). Generally, as a substance's carbon number increases, its molecular weight increases and it is therefore, not a substance of concern via inhalation. The working group also concluded that aromatic hydrocarbons tend to be more toxic than aliphatic hydrocarbons (Reference 15).

(f) Table 5 tabulates the inhalation toxicity values used to evaluate exposure to petroleum mixtures. To be consistent with the methodology used in this study, the reference concentrations (RfCs) were converted to PRGs using Region 9 assumptions. The resulting PRGs are included in Table D-4 in Appendix D.

TABLE 5: SUMMARY OF RfCs USED FOR PETROLEUM HYDROCARBONS (Reference 15)

Carbon Range	Aromatic Inhalation RfC (mg/m^3)	Aliphatic Inhalation RfC (mg/m^3)
$C_5 - C_6$ $C_{>6} - C_8$		18.4
$C_{>7} - C_8$	0.4	
$C_{>8} - C_{10}$ $C_{>10} - C_{12}$ $C_{>12} - C_{16}$	0.2	1.0
$C_{>16} - C_{21}$ $C_{>21} - C_{35}$	NA	NA

NA = not applicable for high molecular weight TPHs ($C_{>16}$) because compounds in this carbon range are not volatile and therefore, inhalation is not a pathway of concern.

[1] Aliphatic hydrocarbons are hydrocarbons in which the carbon atoms are joined by single covalent bonds consisting of two shared electrons (e.g., butane). Aromatic hydrocarbons have ring structures (e.g., benzene) (Reference 21).

(2) ACUTE ASSESSMENT

(a) As previously indicated, an acceptable method for assessing acute health effects is not currently available. It was not until recently that EPA guidance addressed the need to evaluate acute health effects from inhalation (Reference 16). Even then, acute toxicity data for risk assessment purposes were not readily available. The EPA recognized this deficiency and spearheaded the National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances (NAC/AEGL Committee). However, AEGLs are currently available for only a handful of substances.

(b) To circumvent this problem, several state regulatory agencies have suggested that guidelines developed for emergency purposes be used in the interim. Although suggestions have been made to use occupational exposure limits (OELs) by applying additional safety factors (References 17, 18), OELs were not used in this study because they introduce even more uncertainty than the use of emergency guidelines. OELs are designed to protect the workplace environment and assume 8 hours a day, 5 days a week exposures. By definition, these exposures are more chronic than acute.

(c) In comparison, emergency planning guidelines are more appropriate because they are typically developed exposures of 1-hour or less. In addition, safety factors may also have been included depending on the agency that develops these guidelines, so that the values would be protective of the general population.

(d) Emergency Response Planning Guidelines (ERPGs) published by the American Industrial Hygiene Association (AIHA) (Reference 19) and the Temporary Emergency Exposure Limits (TEELs) developed by the U.S. Department of Energy (DOE) (Reference 20) were used for this study; specifically the ERPG-1s and the TEEL-1s. Since TEEL-1s are intended for 15-minute exposures, air concentrations compared to TEELs were averaged over a 15-minute period as opposed to 1-hour in this assessment. The AIHA defines ERPG-1 as follows:

"The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor."

The DOE defines TEEL-1 as follows:

"The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor."

(e) For this study, ERPGs were selected prior to a substance's TEEL because they are vigorously reviewed before they are published whereas the TEELs are not. Example 8 shows a sample calculation of how a substance's estimated acute concentration is compared to its acute toxicity value.

Example 8
Sample Calculation of Comparing a Substance's Estimated Acute Concentration to Its Acute Toxicity Value:

$$\frac{C_{acute(cadmium)}}{ATV} = \frac{1.48E-03}{3.00E+01}$$

= 4.92E-05<1

The acute toxicity value available for cadmium is a TEEL. In this example with cadmium, the ratio is five orders of magnitude below 1, indicating that further analysis is not necessary.

6. RISK CHARACTERIZATION

Appendix D presents results from the M158 risk characterization. Note that for some substances, two concentrations were reported because of different analytical test methods (as noted in bold). In those instances, the higher concentration was used.

a. CHRONIC HEALTH RISK

The outcome indicated that no chronic health risks are expected from breathing the air emissions from the M158. Since all ratios were below one, no further evaluation was needed.

b. ACUTE HEALTH RISK

For the acute analysis, all ratios were below one, indicating that no acute health impacts are expected from breathing the air emissions from the M158. Since all ratios for the acute evaluation were below one, no further assessment was needed.

c. SUBSTANCES WITH NO TOXICITY DATA

Some substances were not quantitatively evaluated because they do not have established toxicity data. By conducting a semi-qualitative comparison of the concentrations of these substances to similar compounds with available toxicity data, it may be concluded that no potential for health effects would be expected from exposure to these substances.

d. FACT SHEET

A copy of the fact sheet submitted to AEC is included as Appendix E. The fact sheet uses the results from this study to summarize health concerns related to inhalation of M158 air emissions.

7. UNCERTAINTY DISCUSSION

The limitations inherent in modeling and the added conservatism of the evaluation contribute to the uncertainty of the study results. The risk assessment methodology typically includes safety factors that are embedded in the toxicity data to ensure adequate protection of the general population, particularly, susceptible individuals such as the sick, elderly, and children. Table 6 identifies areas of uncertainty associated with this assessment.

TABLE 6: TYPES OF UNCERTAINTY

Issue	Uncertainty	Direction of Effect
Modeling		
Modeled versus real-time sampling	The air concentrations in this study were modeled. Actual air concentrations taken from the field may be higher or lower.	Varies
Frequency of use for the M158	Actual frequency of use of M158s during a training event may be different from those stated in this report.	Varies
Hypothetical resident assumed to be located directly downwind	Unless the area around the training facility is populated, the chances that a person living directly downwind is low.	Overestimates
Use of worst-case meteorological conditions	To ensure that this study is applicable to most training areas, worst-case meteorological conditions were used in the air model.	Overestimates
Exposure Assessment		
Estimating time-averaged concentrations	Actual exposure from the M158 is intermittent. If one were to plot a person's exposure profile, the plot would consist of a series of spikes. Since current risk assessment methodology does not allow the evaluation of the potential for health risks as a function of time, a single concentration, averaged over the exposure duration was used. In this study, the exposure durations used were 30 years and 1-hour or 15 minutes.	Varies

TABLE 6: TYPES OF UNCERTAINTY

Issue	Uncertainty	Direction of Effect
Chromium speciation	All chromium was assumed to be present as Cr(VI), which is more toxic than Cr(III).	Overestimates
Comparing estimated concentration to established screening levels	The Region 3 and Region 9 HBSLs were developed using different exposure assumptions than those in this study, resulting in more conservative screening levels.	Overestimates
Screening assessment versus calculating an average daily intake	Calculating an average daily intake allows the use of scenario-specific assumptions. However, unless the ratio of concentration to screening level approaches one, a screening assessment is useful as a first-cut evaluation.	Varies
Exposure to other munitions	Other munitions are typically used during the same training event. These items may contain similar or different substances from those detected in the M158.	Underestimates
Toxicity Assessment		
Lack of toxicity data	Some substances were not quantitatively evaluated because they have no known toxicity data.	Underestimates
Modifying and uncertainty factors for toxicity data	Modifying factors and uncertainty factors of varying degree are typically applied to toxicological values. These factors are used to conservatively account for extrapolating from animal studies for human health evaluation, and to conservatively account for variation in human populations.	Overestimates

8. CONCLUSION

Results indicated that residents who live as close as 100 meters directly downwind from training areas are safe from breathing air emissions from the M158. It is believed that the assumptions contained in this analysis are conservative enough to be protective of all the population including the sick, elderly, and children.

9. RECOMMENDATIONS

Since the results from this study are intended for a hypothetical training facility, they can vary depending on site-specific conditions. However, because of the conservative assumptions used (e.g., worst-case meteorological conditions, receptor located directly downwind, etc.) it is believed that most site-specific analyses would result in even lower concentrations. Therefore, the results from this evaluation should be applicable to most training facilities unless site-specific conditions vary significantly.

10. POINT OF CONTACT

Questions about this report should be directed to Ms. Joleen Mobley at (800) 222-9698 (ext 2953) or (410) 436-2953.

PREPARED BY:

JOLEEN MOBLEY
Environmental Scientist
ATSDR Program

STAFFORD D.F.R. COAKLEY
Environmental Engineer
Environmental Health Risk Assessment
and Risk Communication Program

JEFFREY S. GROW, P.E.
Supervisory Environmental Engineer
Ambient Air Quality Management Program

APPROVED BY:

KATHLEEN M. BUCHI
DOD Lead Agent for the
ATSDR Program

DAVID L. DAUGHDRILL
Program Manager
Environmental Health Risk Assessment
and Risk Communication

JAMES D. WOOD, P.E.
Program Manager
Ambient Air Quality Management

APPENDIX A

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APPENDIX B

AIR DISPERSION MODELING OUTPUT DATA

Table B-1: Air Modeling Output Data for Metals, Particulates, and Miscellaneous Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	g/m^3/(g/s)	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item) M	Pollutant Concentration 1 Item (grams/m^3) CONC	Pollutant Emission Rate (g/sec)/item ER_I	Event Pollutant Emission Rate 1 Item (g/sec) ER_{EV}
Particulate								
TSP	3.813E+01	8.516E-02	3.272E-01	9.161E-02	4.155E+01	6.378E-04	2.309E+00	2.309E+00
PM_{10}	3.697E+01	ND	2.959E-01	8.285E-02	3.758E+01	5.769E-04	2.088E+00	2.088E+00
HCl/Cl_2								
HCl	1.016E-01	3.676E-02	5.860E-04	1.641E-04	7.442E-02	1.142E-06	4.135E-03	4.135E-03
Cl_2	3.676E-02	3.646E-02	2.661E-06	7.451E-07	3.380E-04	5.188E-09	1.878E-05	1.878E-05
Dioxin/Furan								
Dioxin TEQ	6.012E-12	7.123E-11	ND	ND	ND	ND	ND	ND
CEM System								
Carbon Monoxide (CO)	3.134E+00	3.243E-03	2.831E-02	7.927E-03	3.595E+00	5.519E-05	1.997E-01	1.997E-01
Nitrogen Oxide (NOx)	1.302E+00	2.683E-02	1.153E-02	3.228E-03	1.464E+00	2.248E-05	8.135E-02	8.135E-02
HCl	2.950E-01	3.075E-01	ND	ND	ND	ND	ND	ND
Carbon Dioxide (CO_2)	7.169E+02	6.466E+02	6.356E-01	1.780E-01	8.072E+01	1.239E-03	4.484E+00	4.484E+00
Sulfur Dioxide (SO_2)	5.272E-02	3.169E-03	4.481E-04	1.255E-04	5.691E-02	8.736E-07	3.162E-03	3.162E-03
Particulate-phase Metals								
Aluminum	3.374E-02	NM (a)	2.902E-04	8.125E-05	3.686E-02	5.657E-07	2.048E-03	2.048E-03
Antimony	ND	NM (a)	ND	ND	ND	ND	ND	ND
Arsenic	ND	NM (a)	ND	ND	ND	ND	ND	ND
Barium	4.747E-02	NM (a)	4.082E-04	1.143E-04	5.185E-02	7.959E-07	2.880E-03	2.880E-03
Beryllium	ND	NM (a)	ND	ND	ND	ND	ND	ND
Cadmium	2.640E-04	NM (a)	2.271E-06	6.358E-07	2.884E-04	4.427E-09	1.602E-05	1.602E-05
Chromium	4.251E-04	NM (a)	3.656E-06	1.024E-06	4.644E-04	7.128E-09	2.580E-05	2.580E-05
Cobalt	8.184E-05	NM (a)	7.039E-07	1.971E-07	8.940E-05	1.372E-09	4.967E-06	4.967E-06
Copper	1.683E-03	NM (a)	1.448E-05	4.054E-06	1.839E-03	2.822E-08	1.022E-04	1.022E-04
Lead	7.263E-04	NM (a)	6.247E-06	1.749E-06	7.934E-04	1.218E-08	4.408E-05	4.408E-05
Magnesium	1.394E+01	NM (a)	1.199E-01	3.356E-02	1.522E+01	2.337E-04	8.456E-01	8.456E-01
Manganese	5.585E-04	NM (a)	4.804E-06	1.345E-06	6.101E-04	9.365E-09	3.389E-05	3.389E-05
Nickel	2.521E-04	NM (a)	2.168E-06	6.070E-07	2.753E-04	4.227E-09	1.530E-05	1.530E-05
Phosphorus	8.389E-04	NM (a)	7.215E-06	2.020E-06	9.163E-04	1.407E-08	5.091E-05	5.091E-05
Selenium	ND	NM (a)	ND	ND	ND	ND	ND	ND
Silver	ND	NM (a)	ND	ND	ND	ND	ND	ND

Table B-1: Air Modeling Output Data for Metals, Particulates, and Miscellaneous Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
Thallium	ND	NM (a)	ND	ND	ND	ND	ND	ND
Zinc	ND	NM (a)	ND	ND	ND	ND	ND	ND
Mercury	4.034E-05	NM (a)	3.469E-07	9.714E-08	4.406E-05	6.763E-10	2.448E-06	2.448E-06

Footnotes:
ND = Not Detected
NEW = Net Explosive Weight
NM = Not Measureable
a = Insufficient material to analyze.

Table B-2: Air Modeling Output Data for Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I):	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item) M	Pollutant Concentration 1 Item ($grams/m^3$) CONC	Pollutant Emission Rate (g/sec)/item ER_I	Event Pollutant Emission Rate 1 Item (g/sec) ER_{EV}
Total Nonmethane Hydrocarbons (TNMHC)								
TNMHC	1.508E-01	3.050E-02	9.923E-04	2.778E-04	1.260E-01	1.935E-06	7.002E-03	7.002E-03
Volatile Organic Compounds (VOCs)								
Ethane	9.150E-03	1.500E-03	6.313E-05	1.768E-05	8.018E-03	1.231E-07	4.454E-04	4.454E-04
Ethylene	2.170E-02	1.000E-04	1.782E-04	4.991E-05	2.264E-02	3.475E-07	1.258E-03	1.258E-03
Acetylene	1.410E-02	9.000E-04	1.089E-04	3.050E-05	1.383E-02	2.124E-07	7.686E-04	7.686E-04
Propane	1.900E-03	3.000E-04	1.320E-05	3.697E-06	1.677E-03	2.574E-08	9.316E-05	9.316E-05
Propene	9.100E-03	1.000E-04	7.427E-05	2.080E-05	9.432E-03	1.448E-07	5.240E-04	5.240E-04
i-Butane	2.500E-04	2.000E-04	4.126E-07	1.155E-07	5.240E-05	8.044E-10	2.911E-06	2.911E-06
i-Butene	7.000E-04	1.000E-04	4.951E-06	1.386E-06	6.288E-04	9.653E-09	3.494E-05	3.494E-05
1-Butene	1.350E-03	ND	1.114E-05	3.119E-06	1.415E-03	2.172E-08	7.860E-05	7.860E-05
1,3-Butadiene	1.200E-03	ND	9.902E-06	2.773E-06	1.258E-03	1.931E-08	6.987E-05	6.987E-05
n-Butane	8.000E-04	4.000E-04	3.301E-06	9.242E-07	4.192E-04	6.435E-09	2.329E-05	2.329E-05
trans-2-Butene	1.150E-03	ND	9.490E-06	2.657E-06	1.205E-03	1.850E-08	6.696E-05	6.696E-05
2,2-Dimethylpropane	ND	ND	ND	ND	ND	ND	ND	ND
cis-2-Butene	4.500E-04	ND	3.713E-06	1.040E-06	4.716E-04	7.239E-09	2.620E-05	2.620E-05
3-Methyl-1-butene	ND	ND	ND	ND	ND	ND	ND	ND
i-Pentane	8.000E-04	2.000E-04	4.951E-06	1.386E-06	6.288E-04	9.653E-09	3.494E-05	3.494E-05
1-Pentene	5.000E-04	ND	4.126E-06	1.155E-06	5.240E-04	8.044E-09	2.911E-05	2.911E-05
2-Methyl-1-butene	3.500E-04	ND	2.888E-06	8.087E-07	3.668E-04	5.631E-09	2.038E-05	2.038E-05
n-Pentane	2.050E-03	2.000E-04	1.527E-05	4.275E-06	1.939E-03	2.976E-08	1.077E-04	1.077E-04
Isoprene	2.000E-04	ND	1.650E-06	4.621E-07	2.096E-04	3.218E-09	1.165E-05	1.165E-05
trans-2-Pentene	5.500E-04	ND	4.539E-06	1.271E-06	5.764E-04	8.848E-09	3.202E-05	3.202E-05
cis-2-Pentene	1.000E-04	ND	8.252E-07	2.311E-07	1.048E-04	1.609E-09	5.823E-06	5.823E-06
2-Methyl-2-butene	2.000E-04	ND	1.650E-06	4.621E-07	2.096E-04	3.218E-09	1.165E-05	1.165E-05
2,2-Dimethylbutane	ND	ND	ND	ND	ND	ND	ND	ND
Cyclopentene	1.000E-04	ND	8.252E-07	2.311E-07	1.048E-04	1.609E-09	5.823E-06	5.823E-06
4-Methyl-1-pentene	ND	ND	ND	ND	ND	ND	ND	ND
Cyclopentane	ND	ND	ND	ND	ND	ND	ND	ND
2,3-Dimethylbutane	ND	ND	ND	ND	ND	ND	ND	ND
cis-4-Methyl-2-pentene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylpentane	3.500E-04	1.000E-04	2.063E-06	5.776E-07	2.620E-04	4.022E-09	1.456E-05	1.456E-05
3-Methylpentane	4.000E-04	ND	3.301E-06	9.242E-07	4.192E-04	6.435E-09	2.329E-05	2.329E-05

Table B-2: Air Modeling Output Data for Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I):	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
2-Methyl-1-pentene	ND	ND	ND	ND	ND	ND	ND	ND
1-Hexene	5.000E-04	ND	4.126E-06	1.155E-06	5.240E-04	8.044E-09	2.911E-05	2.911E-05
n-Hexane	4.500E-04	2.000E-04	2.063E-06	5.776E-07	2.620E-04	4.022E-09	1.456E-05	1.456E-05
trans-2-Hexene	ND	ND	ND	ND	ND	ND	ND	ND
2-Methyl-2-pentene	ND	ND	ND	ND	ND	ND	ND	ND
cis-2-Hexene	ND	ND	ND	ND	ND	ND	ND	ND
Methylcyclopentane	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylpentane	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	1.070E-02	1.100E-03	7.922E-05	2.218E-05	1.006E-02	1.544E-07	5.590E-04	5.590E-04
Cyclohexane	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylhexane	2.000E-04	1.000E-04	8.252E-07	2.311E-07	1.048E-04	1.609E-09	5.823E-06	5.823E-06
2,3-Dimethylpentane	5.000E-04	2.000E-04	2.476E-06	6.932E-07	3.144E-04	4.826E-09	1.747E-05	1.747E-05
3-Methylhexane	4.000E-04	4.000E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2,2,4-Trimethylpentane	1.050E-03	5.000E-04	4.539E-06	1.271E-06	5.764E-04	8.848E-09	3.202E-05	3.202E-05
n-Heptane	ND	2.000E-04	ND	ND	ND	ND	ND	ND
2,4,4-Trimethyl-1-pentene	ND	ND	ND	ND	ND	ND	ND	ND
Methylcyclohexane	ND	1.000E-04	ND	ND	ND	ND	ND	ND
2,4,4-Trimethyl-2-pentene	ND	ND	ND	ND	ND	ND	ND	ND
2,5-Dimethylhexane	ND	1.000E-04	ND	ND	ND	ND	ND	ND
2,4-Dimethylhexane	ND	1.000E-04	ND	ND	ND	ND	ND	ND
2,3,4-Trimethylpentane	2.500E-04	2.000E-04	4.126E-07	1.155E-07	5.240E-05	8.044E-10	2.911E-06	2.911E-06
Toluene	4.550E-03	1.100E-03	2.847E-05	7.971E-06	3.616E-03	5.550E-08	2.009E-04	2.009E-04
2,3-Dimethylhexane	ND	1.000E-04	ND	ND	ND	ND	ND	ND
2-Methylheptane	ND	1.000E-04	ND	ND	ND	ND	ND	ND
3-Ethylhexane	ND	ND	ND	ND	ND	ND	ND	ND
2,2-Dimethylheptane	ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-Trimethylhexane	ND	ND	ND	ND	ND	ND	ND	ND
n-Octane	3.000E-04	1.000E-04	1.650E-06	4.621E-07	2.096E-04	3.218E-09	1.165E-05	1.165E-05
Ethylcyclohexane	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	2.250E-03	9.000E-04	1.114E-05	3.119E-06	1.415E-03	2.172E-08	7.860E-05	7.860E-05
m-Xylene & p-Xylene	8.200E-03	4.500E-03	3.053E-05	8.549E-06	3.878E-03	5.952E-08	2.154E-04	2.154E-04
Styrene	1.000E-03	ND	8.252E-06	2.311E-06	1.048E-03	1.609E-08	5.823E-05	5.823E-05
o-Xylene	2.950E-03	1.700E-03	1.032E-05	2.888E-06	1.310E-03	2.011E-08	7.278E-05	7.278E-05
n-Nonane	1.200E-03	ND	9.902E-06	2.773E-06	1.258E-03	1.931E-08	6.987E-05	6.987E-05
i-Propylbenzene	ND	ND	ND	ND	ND	ND	ND	ND

Table B-2: Air Modeling Output Data for Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I):	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
n-Propylbenzene	1.500E-04	1.000E-04	4.126E-07	1.155E-07	5.240E-05	8.044E-10	2.911E-06	2.911E-06
p-Ethyltoluene	5.500E-04	3.000E-04	2.063E-06	5.776E-07	2.620E-04	4.022E-09	1.456E-05	1.456E-05
m-Ethyltoluene	1.500E-04	1.000E-04	4.126E-07	1.155E-07	5.240E-05	8.044E-10	2.911E-06	2.911E-06
1,3,5-Trimethylbenzene	2.000E-04	1.000E-04	8.252E-07	2.311E-07	1.048E-04	1.609E-09	5.823E-06	5.823E-06
o-Ethyltoluene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene & sec-Butylbenzene	5.500E-04	4.000E-04	1.238E-06	3.466E-07	1.572E-04	2.413E-09	8.734E-06	8.734E-06
n-Decane	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Pinene	ND	ND	ND	ND	ND	ND	ND	ND
beta-Pinene	ND	ND	ND	ND	ND	ND	ND	ND
delta 3-Carene	ND	ND	ND	ND	ND	ND	ND	ND
d-Limonene	ND	ND	ND	ND	ND	ND	ND	ND
MTBE	4.000E-04	ND	3.301E-06	9.242E-07	4.192E-04	6.435E-09	2.329E-05	2.329E-05
Dichlorodifluoromethane	7.538E-04	1.550E-03	ND	ND	ND	ND	ND	ND
Methylchloride	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorotetrafluoroethane	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethene	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Butadiene	1.221E-03	ND	1.007E-05	2.820E-06	1.279E-03	1.964E-08	7.107E-05	7.107E-05
Methylbromide	ND	ND	ND	ND	ND	ND	ND	ND
Ethylchloride	ND	ND	ND	ND	ND	ND	ND	ND
Trichloromonofluoromethane	2.645E-03	2.565E-03	6.625E-07	1.855E-07	8.414E-05	1.292E-09	4.675E-06	4.675E-06
Vinylidenechloride	ND	ND	ND	ND	ND	ND	ND	ND
Methylenechloride	ND	ND	ND	ND	ND	ND	ND	ND
Allylchloride	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	1.405E-03	1.120E-03	2.345E-06	6.566E-07	2.978E-04	4.572E-09	1.655E-05	1.655E-05
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Methylchloroform	3.306E-04	2.943E-04	2.996E-07	8.389E-08	3.805E-05	5.841E-10	2.114E-06	2.114E-06
Benzene	1.088E-02	1.119E-03	8.058E-05	2.256E-05	1.023E-02	1.571E-07	5.685E-04	5.685E-04
Carbontetrachloride	8.101E-04	7.028E-04	8.857E-07	2.480E-07	1.125E-04	1.727E-09	6.250E-06	6.250E-06
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethylene	ND	ND	ND	ND	ND	ND	ND	ND
cis 1,3-Dichloro-1-propene	ND	ND	ND	ND	ND	ND	ND	ND
trans 1,3-Dichloro-1-propene	ND	ND	ND	ND	ND	ND	ND	ND

Table B-2: Air Modeling Output Data for Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	4.628E-03	1.119E-03	2.896E-05	8.108E-06	3.678E-03	5.645E-08	2.043E-04	2.043E-04
1,2-Dibromoethane	ND	ND	ND	ND	ND	ND	ND	ND
Perchloroethylene	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	3.454E-03	1.382E-03	1.710E-05	4.789E-06	2.172E-03	3.334E-08	1.207E-04	1.207E-04
m&p-Xylene	8.340E-03	4.577E-03	3.106E-05	8.696E-06	3.944E-03	6.054E-08	2.191E-04	2.191E-04
Styrene	1.017E-03	ND	8.393E-06	2.350E-06	1.066E-03	1.636E-08	5.922E-05	5.922E-05
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND
o-Xylene	3.001E-03	1.729E-03	1.049E-05	2.938E-06	1.332E-03	2.045E-08	7.403E-05	7.403E-05
p-Ethyltoluene	5.594E-04	3.051E-04	2.098E-06	5.875E-07	2.665E-04	4.091E-09	1.481E-05	1.481E-05
1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	5.594E-04	4.068E-04	1.259E-06	3.525E-07	1.599E-04	2.454E-09	8.883E-06	8.883E-06
Benzylchloride	ND	ND	ND	ND	ND	ND	ND	ND
m-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
p-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
o-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
o-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND	ND
p-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Methylnitrite	1.888E-03	ND	1.558E-05	4.363E-06	1.979E-03	3.038E-08	1.100E-04	1.100E-04
Acetonitrile	7.002E-04	ND	5.778E-06	1.618E-06	7.339E-04	1.126E-08	4.077E-05	4.077E-05
Acrylonitrile	8.729E-04	ND	7.203E-06	2.017E-06	9.149E-04	1.404E-08	5.083E-05	5.083E-05
Nitromethane	1.565E-03	ND	1.291E-05	3.616E-06	1.640E-03	2.518E-08	9.112E-05	9.112E-05
Benzonitrile	3.832E-04	ND	3.163E-06	8.855E-07	4.017E-04	6.165E-09	2.231E-05	2.231E-05
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Carbonyl Sulfide	1.852E-04	ND	1.528E-06	4.279E-07	1.941E-04	2.979E-09	1.078E-05	1.078E-05
Sulfur Dioxide	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	7.221E-03	8.722E-04	5.239E-05	1.467E-05	6.654E-03	1.021E-07	3.697E-04	3.697E-04
Thiophene	4.472E-04	ND	3.690E-06	1.033E-06	4.686E-04	7.194E-09	2.604E-05	2.604E-05
Dimethyldisulfide	ND	ND	ND	ND	ND	ND	ND	ND

Table B-2: Air Modeling Output Data for Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I):	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
2-Methylthiophene	ND	ND	ND	ND	ND	ND	ND	ND
3-Methylthiophene	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyltrisulfide	ND	ND	ND	ND	ND	ND	ND	ND
Isothiocyanatomethane	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorothiophene	ND	ND	ND	ND	ND	ND	ND	ND
3-Chlorothiophene	ND	ND	ND	ND	ND	ND	ND	ND
2-Thiophenecarboxaldehyde	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	1.025E-03	ND	8.456E-06	2.368E-06	1.074E-03	1.649E-08	5.967E-05	5.967E-05
Acetaldehyde	5.105E-04	1.200E-04	3.222E-06	9.023E-07	4.093E-04	6.282E-09	2.274E-05	2.274E-05
Acrolein	1.256E-03	ND	1.036E-05	2.902E-06	1.316E-03	2.020E-08	7.312E-05	7.312E-05
Acetone	1.097E-02	6.543E-03	3.649E-05	1.022E-05	4.635E-03	7.114E-08	2.575E-04	2.575E-04
Propanal	9.525E-04	ND	7.860E-06	2.201E-06	9.982E-04	1.532E-08	5.546E-05	5.546E-05
Furan	1.494E-03	ND	1.233E-05	3.453E-06	1.566E-03	2.404E-08	8.701E-05	8.701E-05
2-Propanol	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylpropanal	ND	ND	ND	ND	ND	ND	ND	ND
Methacrolein	2.840E-04	ND	2.344E-06	6.563E-07	2.977E-04	4.569E-09	1.654E-05	1.654E-05
2,3-Butanedione	ND	ND	ND	ND	ND	ND	ND	ND
Methyl-Vinyl Ketone	3.843E-04	ND	3.172E-06	8.880E-07	4.028E-04	6.183E-09	2.238E-05	2.238E-05
MTBE	2.237E-04	ND	1.846E-06	5.168E-07	2.344E-04	3.598E-09	1.302E-05	1.302E-05
Butanal	4.765E-04	4.731E-04	2.821E-08	7.900E-09	3.583E-06	5.500E-11	1.991E-07	1.991E-07
2-Butanone	1.677E-03	6.063E-04	8.835E-06	2.474E-06	1.122E-03	1.722E-08	6.234E-05	6.234E-05
Tetrahydrofuran	3.230E-04	ND	2.665E-06	7.463E-07	3.385E-04	5.196E-09	1.881E-05	1.881E-05
2-Methyl-1-propanol	ND	ND	ND	ND	ND	ND	ND	ND
trans-2-Butenal	2.587E-04	ND	2.135E-06	5.977E-07	2.711E-04	4.161E-09	1.506E-05	1.506E-05
Acetic Acid	5.884E-04	ND	4.856E-06	1.360E-06	6.167E-04	9.466E-09	3.426E-05	3.426E-05
2-Pentanone	1.430E-03	ND	1.180E-05	3.303E-06	1.498E-03	2.300E-08	8.324E-05	8.324E-05
Pentanal	1.552E-03	1.441E-03	9.140E-07	2.559E-07	1.161E-04	1.782E-09	6.449E-06	6.449E-06
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND
trans-2-Pentenal	ND	ND	ND	ND	ND	ND	ND	ND
Cyclopentanone	2.673E-04	ND	2.206E-06	6.177E-07	2.802E-04	4.301E-09	1.557E-05	1.557E-05
2-Hexanone	2.114E-04	ND	1.744E-06	4.883E-07	2.215E-04	3.400E-09	1.231E-05	1.231E-05
Hexanal	5.319E-04	6.452E-04	ND	ND	ND	ND	ND	ND
3-Furaldehyde	ND	ND	ND	ND	ND	ND	ND	ND
Butyl Acetate	5.412E-04	ND	4.466E-06	1.251E-06	5.672E-04	8.707E-09	3.151E-05	3.151E-05
2-Furaldehyde	2.487E-03	ND	2.052E-05	5.746E-06	2.607E-03	4.001E-08	1.448E-04	1.448E-04

Table B-2: Air Modeling Output Data for Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
trans-2-Hexenal	ND	ND	ND	ND	ND	ND	ND	ND
1-Hexanol	ND	ND	ND	ND	ND	ND	ND	ND
3-Heptanone	6.145E-04	3.394E-04	2.270E-06	6.356E-07	2.883E-04	4.425E-09	1.602E-05	1.602E-05
2-Heptanone	ND	ND	ND	ND	ND	ND	ND	ND
Heptanal	6.061E-04	5.100E-04	7.934E-07	2.222E-07	1.008E-04	1.547E-09	5.598E-06	5.598E-06
trans-2-Heptenal	ND	ND	ND	ND	ND	ND	ND	ND
5-Methyl-2-furaldehyde	ND	ND	ND	ND	ND	ND	ND	ND
6-Methyl-2-heptanone	ND	ND	ND	ND	ND	ND	ND	ND
Benzaldehyde	1.662E-03	5.292E-04	9.345E-06	2.616E-06	1.187E-03	1.822E-08	6.593E-05	6.593E-05
1-Heptanol	ND	ND	ND	ND	ND	ND	ND	ND
6-Methyl-5-hepten-2-one	ND	4.419E-04	ND	ND	ND	ND	ND	ND
2-Octanone	ND	ND	ND	ND	ND	ND	ND	ND
Octanal	1.493E-03	5.251E-04	7.986E-06	2.236E-06	1.014E-03	1.557E-08	5.635E-05	5.635E-05
Benzofuran	7.659E-04	ND	6.320E-06	1.770E-06	8.027E-04	1.232E-08	4.459E-05	4.459E-05
trans-2-Octenal	ND	ND	ND	ND	ND	ND	ND	ND
Acetophenone	4.169E-04	ND	3.440E-06	9.633E-07	4.369E-04	6.707E-09	2.427E-05	2.427E-05
2-Nonanone	ND	ND	ND	ND	ND	ND	ND	ND
Nonanal	2.102E-03	5.656E-04	1.268E-05	3.550E-06	1.610E-03	2.472E-08	8.946E-05	8.946E-05
trans-2-Nonenal	ND	ND	ND	ND	ND	ND	ND	ND
2-Decanone	ND	ND	ND	ND	ND	ND	ND	ND
Decanal	ND	ND	ND	ND	ND	ND	ND	ND

Footnotes:
ND = Not Detected
NEW = Net Explosive Weight
Items in bold represent duplicate values for those compounds that are common for Method TO-14 and TO-12.

Table B-3: Air Modeling Output Data for Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item) M	Pollutant Concentration 1 Item ($grams/m^3$) CONC	Pollutant Emission Rate (g/sec)/item ER_1	Event Pollutant Emission Rate 1 Item (g/sec) ER_{EV}
Particulate/Vapor-phase SVOCs								
N-Nitrosodimethylamine	ND	ND	ND	ND	ND	ND	ND	ND
Pyridine	ND	ND	ND	ND	ND	ND	ND	ND
2-Picoline	ND	ND	ND	ND	ND	ND	ND	ND
Methyl methanesulfonate	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosomethylethylamine	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiethylamine	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl methanesulfonate	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND
Aniline	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl)ether	ND	ND	ND	ND	ND	ND	ND	ND
Pentachloroethane	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl)ether	ND	ND	ND	ND	ND	ND	ND	ND
o-Toluidine	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol/3-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	ND	ND	ND	ND	ND	ND	ND
Acetophenone	4.841E-04	3.066E-04	1.606E-06	4.496E-07	2.039E-04	3.130E-09	1.133E-05	1.133E-05
N-Nitrosomorpholine	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosopyrrolidine	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosopiperidine	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)methane	ND	ND	ND	ND	ND	ND	ND	ND

Table B-3: Air Modeling Output Data for Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
Benzoic acid	ND	2.394E-03	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	3.938E-04	ND	3.561E-06	9.972E-07	4.523E-04	6.943E-09	2.513E-05	2.513E-05
p-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloropropene	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphenethylamine	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-butylamine	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND
Safrole	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4,5-Tetrachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND
Isosafrole	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Naphthoquinone	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
1-Naphthylamine	ND	ND	ND	ND	ND	ND	ND	ND
2-Naphthylamine	ND	ND	ND	ND	ND	ND	ND	ND

Table B-3: Air Modeling Output Data for Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
2,3,4,6-Tetrachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	5.003E-04	5.896E-04	ND	ND	ND	ND	ND	ND
4-Chlorophenylphenyl ether	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND
5-Nitro-o-toluidine	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND
Diphenylamine/N-NitrosoDPA	ND	ND	ND	ND	ND	ND	ND	ND
sym-Trinitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Diallate	ND	ND	ND	ND	ND	ND	ND	ND
Phenacetin	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenylphenyl ether	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
4-Aminobiphenyl	ND	ND	ND	ND	ND	ND	ND	ND
Pronamide	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND
Pentachloronitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND
Carbazole	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	7.295E-04	1.957E-03	ND	ND	ND	ND	ND	ND
4-Nitroquinoline-1-oxide	ND	ND	ND	ND	ND	ND	ND	ND
Methapyrilene	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Benzidine	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND
p-Dimethylaminoazobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzilate	ND	ND	ND	ND	ND	ND	ND	ND
Kepone	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	6.269E-04	ND	5.669E-06	1.587E-06	7.200E-04	1.105E-08	4.000E-05	4.000E-05
3,3'-Dimethylbenzidine	ND	ND	ND	ND	ND	ND	ND	ND
2-Acetylaminofluorene	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	1.240E-03	5.277E-04	6.438E-06	1.803E-06	8.176E-04	1.255E-08	4.542E-05	4.542E-05
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND

Table B-3: Air Modeling Output Data for Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare				Items per event (I)	1	items/day	
	NEW, lb = 1.67				release duration (t):	18	seconds	
	Number of Items = 1				Unit Concentration (UC):	2.763E-04	$g/m^3/(g/s)$	
Compound	Measured Actual Concentration (mg/m^3)	Measured Background Concentration (mg/m^3)	Average Adjusted Emission Factor (lb/lb NEW)	Average Adjusted Emission Factor (lb/item)	Total Mass of Pollutant Emitted (grams/item)	Pollutant Concentration 1 Item ($grams/m^3$)	Pollutant Emission Rate (g/sec)/item	Event Pollutant Emission Rate 1 Item (g/sec)
Benz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate	2.694E-04	ND	2.436E-06	6.822E-07	3.094E-04	4.750E-09	1.719E-05	1.719E-05
7,12-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Benz(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND
3-Methylcholanthrene	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND

Footnotes:
ND = Not Detected
NEW = Net Explosive Weight

APPENDIX C

HEALTH-BASED SCREENING LEVELS AND ACUTE TOXICITY VALUES

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
TSP	12789-66-1	5.00E+01		NA		5.00E+01	NA	NA		
PM_{10}		5.00E+01		NA		5.00E+01	NA	NA		
HCl	7647-01-0	2.08E+01	nc	2.08E+01	nc	2.08E+01	NA	7.14E+03	T	7.14E+03
Cl_2	7782-50-5	2.09E-01	nc	3.65E+02	nc	2.09E-01	2.89E+03	2.90E+03	E	2.89E+03
Dioxin TEQ	1746-01-6	4.48E-08	c	4.48E-08	c	4.48E-08	NA	3.50E+00	T	3.50E+00
Carbon Monoxide (CO)	630-08-0	1.57E+02		NA		1.57E+02	2.30E+05	2.28E+05	E	2.30E+05
Nitrogen Oxide (NOx)	10024-97-2	1.00E+02		NA		1.00E+02	NA	2.70E+05	T	2.70E+05
HCl (CEM System)	7647-01-0	2.08E+01	nc	2.08E+01	nc	2.08E+01	NA	7.14E+03	T	7.14E+03
Carbon Dioxide (CO_2)	124-38-9	NA		NA		NA	NA	5.40E+07	T	5.40E+07
Sulfur Dioxide (SO_2)	202-58-84	8.00E+01		NA		8.00E+01	7.89E+02	7.86E+02	E	7.89E+02
Aluminum	7429-90-5	NA		3.65E+00	nc	3.65E+00	NA	3.00E+04	T	3.00E+04
Antimony	7440-36-0	NA		1.46E+00	nc	1.46E+00	NA	1.50E+03	T	1.50E+03
Arsenic	7440-38-2	4.47E-04	c	4.15E-04	c	4.47E-04	NA	3.00E+01	T	3.00E+01
Barium	7440-39-3	5.21E-01	nc	5.11E-01	nc	5.21E-01	NA	1.50E+03	T	1.50E+03
Beryllium	7440-41-7	8.00E-04	c	7.45E-04	c	8.00E-04	NA	5.00E+00	T	5.00E+00
Cadmium	7440-43-9	1.07E-03	c	9.94E-04	c	1.07E-03	NA	3.00E+01	T	3.00E+01
Chromium	7440-43-9	NA	c	1.53E-04	c	1.53E-04	NA	1.50E+03	T	1.50E+03
Cobalt	7440-48-4	NA		2.20E+02	nc	2.20E+02	NA	6.00E+01	T	6.00E+01
Copper	7440-50-8	NA		1.46E+02	nc	1.46E+02	NA	3.00E+03	T	3.00E+03
Lead	7439-92-1	1.50E+00		NA		1.50E+00	NA	1.50E+02	T	1.50E+02
Magnesium	7439-95-4	NA		NA		NA	NA	3.00E+04	T	3.00E+04
Manganese	7439-96-5	5.11E-02	nc	5.22E-02	nc	5.11E-02	NA	3.00E+03	T	3.00E+03
Nickel	7440-02-0	NA		7.30E+01	nc	7.30E+01	NA	3.00E+03	T	3.00E+03
Phosphorus	7723-14-0	NA		NA		NA	NA	3.00E+02	T	3.00E+02
Selenium	7782-49-2	NA		1.83E+01	nc	1.83E+01	NA	6.00E+02	T	6.00E+02
Silver	7740-22-4	NA		1.83E+01	nc	1.83E+01	NA	3.00E+02	T	3.00E+02
Thallium	7440-28-0	NA		2.56E-01	nc	2.56E-01	NA	3.00E+02	T	3.00E+02
Zinc	7440-66-6	NA		1.10E+03	nc	1.10E+03	NA	3.00E+04	T	3.00E+04
Mercury	7439-97-6	3.13E-01	nc	3.14E-01	nc	3.13E-01	NA	1.00E+02	T	1.00E+02
TNMHC		NA		NA		NA	NA	NA		
Ethane	74-84-0	NA		NA		NA	NA	NA		
Ethylene	74-85-1	NA		NA		NA	NA	4.60E+05	T	4.60E+05
Acetylene	74-86-2	NA		NA		NA	NA	NA		
Propane	74-98-6	NA		NA		NA	NA	3.78E+06	T	3.78E+06
Propene	115-07-1	NA		NA		NA	NA	NA		
i-Butane	106-97-8	NA		NA		NA	NA	5.71E+06	T	5.71E+06
i-Butene	25167-67-3	NA		NA		NA	NA	NA		
1-Butene	106-98-9	NA		NA		NA	NA	NA		
1,3-Butadiene	106-99-0	3.74E-03	c	3.48E-03	c	3.74E-03	2.20E+04	2.21E+04	E	2.20E+04

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
n-Butane	106-97-8	NA		NA		NA	NA	5.71E+06	T	5.71E+06
trans-2-Butene	624-64-6	NA		NA		NA	NA	NA		
2,2-Dimethylpropane	463-82-1	NA		NA		NA	NA	NA		
cis-2-Butene	590-18-1	NA		NA		NA	NA	NA		
3-Methyl-1-butene	563-45-1	NA		NA		NA	NA	NA		
i-Pentane	109-66-0	NA		NA		NA	NA	1.80E+06	T	1.80E+06
1-Pentene	109-67-1	NA		NA		NA	NA	NA		
2-Methyl-1-butene	563-46-2	NA		NA		NA	NA	NA		
n-Pentane	109-66-0	NA		NA		NA	NA	1.80E+06	T	1.80E+06
Isoprene	78-79-5	NA		NA		NA	NA	NA		
trans-2-Pentene	646-04-8	NA		NA		NA	NA	NA		
cis-2-Pentene	627-20-3	NA		NA		NA	NA	NA		
2-Methyl-2-butene	513-35-9	NA		NA		NA	NA	NA		
2,2-Dimethylbutane	75-83-2	NA		NA		NA	NA	1.80E+06	T	1.80E+06
Cyclopentene	142-29-0	NA		NA		NA	NA	NA		
4-Methyl-1-pentene	691-37-2	NA		NA		NA	NA	NA		
Cyclopentane	287-92-3	NA		NA		NA	NA	NA		
2,3-Dimethylbutane	79-29-8	NA		NA		NA	NA	NA		
cis-4-Methyl-2-pentene	691-38-3	NA		NA		NA	NA	NA		
2-Methylpentane	107-83-5	NA		NA		NA	NA	1.80E+06	T	1.80E+06
3-Methylpentane	96-14-0	NA		NA		NA	NA	NA		
2-Methyl-1-pentene	763-29-1	NA		NA		NA	NA	NA		
1-Hexene	592-41-6	NA		NA		NA	NA	1.03E+05	T	1.03E+05
n-Hexane	110-54-3	2.10E+02	nc	2.1E+02	nc	2.10E+02	NA	5.28E+05	T	5.28E+05
trans-2-Hexene	4050-45-7	NA		NA		NA	NA	NA		
2-Methyl-2-pentene	625-27-4	NA		NA		NA	NA	NA		
cis-2-Hexene	7688-21-3	NA		NA		NA	NA	NA		
Methylcyclopentane	96-37-7	NA		NA		NA	NA	NA		
2,4-Dimethylpentane	108-08-7	NA		NA		NA	NA	NA		
Benzene	71-43-2	2.50E-01	c	2.2E-01	c	2.50E-01	1.56E+05	1.60E+05	E	1.56E+05
Cyclohexane	110-82-7	NA		NA		NA	NA	3.10E+06	T	3.10E+06
2-Methylhexane	591-76-4	NA		NA		NA	NA	NA		
2,3-Dimethylpentane	565-59-3	NA		NA		NA	NA	NA		
3-Methylhexane	589-34-4	NA		NA		NA	NA	NA		
2,2,4-Trimethylpentane	540-84-1	NA		NA		NA	NA	3.50E+05	T	3.50E+05
n-Heptane	142-82-5	NA		NA		NA	NA	1.80E+06	T	1.80E+06
2,4,4-Trimethyl-1-pentene	107-39-1	NA		NA		NA	NA	NA		
Methylcyclohexane	108-87-2	3.10E+03	nc	3.1E+03	nc	3.10E+03	NA	4.81E+06	T	4.81E+06
2,4,4-Trimethyl-2-pentene	107-40-4	NA		NA		NA	NA	NA		

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
2,5-Dimethylhexane	592-13-2	NA		NA		NA	NA	NA		
2,4-Dimethylhexane	589-43-5	NA		NA		NA	NA	NA		
2,3,4-Trimethylpentane	565-59-3	NA		NA		NA	NA	NA		
Toluene	108-88-3	4.02E+02	nc	4.16E+02	nc	4.02E+02	1.88E+05	1.89E+05	E	1.88E+05
2,3-Dimethylhexane	584-94-1	NA		NA		NA	NA	NA		
2-Methylheptane	592-27-8	NA		NA		NA	NA	NA		
3-Ethylhexane	619-99-8	NA		NA		NA	NA	NA		
2,2-Dimethylheptane	1071-26-7	NA		NA		NA	NA	NA		
2,2,4-Trimethylhexane	16747-26-5	NA		NA		NA	NA	NA		
n-Octane	111-65-9	NA		NA		NA	NA	NA		
Ethylcyclohexane	1678-91-7	NA		NA		NA	NA	NA		
Ethylbenzene	100-41-4	1.10E+03	nc	1.1E+03	nc	1.10E+03	NA	5.43E+05	T	5.43E+05
m-Xylene & p-Xylene	108-38-3	NA		NA		NA	NA	6.51E+05	T	6.51E+05
Styrene	100-42-5	1.10E+03	nc	1.0E+03	nc	1.10E+03	2.13E+05	2.13E+05	E	2.13E+05
o-Xylene	95-47-6	NA		7.3E+03	nc	7.30E+03	NA	6.51E+05	T	6.51E+05
n-Nonane	111-84-2	NA		4.0E+02	nc	4.02E+02	NA	1.05E+06	T	1.05E+06
i-Propylbenzene	98-82-8	4.00E+02	nc	4.0E+02	nc	4.00E+02	NA	NA		
n-Propylbenzene	103-65-1	3.65E+01	nc	1.5E+02	nc	3.65E+01	NA	NA		
p-Ethyltoluene	622-96-8	NA		NA		NA	NA	1.25E+05	T	1.25E+05
m-Ethyltoluene	620-14-4	NA		NA		NA	NA	NA		
1,3,5-Trimethylbenzene	108-67-8	6.20E+00	nc	6.2E+00	nc	6.20E+00	NA	3.68E+05	T	3.68E+05
o-Ethyltoluene	611-14-3	NA		NA		NA	NA	7.50E+02	T	7.50E+02
1,2,4-Trimethylbenzene & sec-Butylbenzene	95-63-6	6.21E+00	nc	6.21E+00	nc	6.21E+00	NA	1.80E+05	T	1.80E+05
n-Decane	124-18-5	NA		NA		NA	NA	4.37E+03	T	4.37E+03
alpha-Pinene	80-56-8	NA		NA		NA	NA	4.00E+04	T	4.00E+04
beta-Pinene	127-91-3	NA		NA		NA	NA	NA		
delta 3-Carene	13466-78-9	NA		NA		NA	NA	NA		
d-Limonene	5989-27-5	NA		NA		NA	NA	1.95E+06	T	1.95E+06
MTBE	1634-04-4	3.10E+03	nc	3.1E+03	nc	3.10E+03	NA	4.32E+05	T	4.32E+05
Dichlorodifluoromethane	75-71-8	2.10E+02	nc	1.8E+02	nc	2.10E+02	NA	1.48E+07	T	1.48E+07
Methylchloride	74-87-33	NA		NA		NA	NA	NA		
Dichlorotetrafluoroethane	374-07-2	NA		NA		NA	NA	NA		
Chloroethene	75-01-4	2.20E-02	c	2.1E-02	c	2.20E-02	NA	1.28E+04	T	1.28E+04
1,3-Butadiene	106-99-0	3.74E-03	c	3.48E-03	c	3.74E-03	2.20E+04	2.21E+04	E	2.20E+04
Methylbromide	74-83-9	5.20E+00	nc	5.1E+00	nc	5.20E+00	NA	5.82E+04	T	5.82E+04
Ethylchloride	75-00-3	2.30E+00	c	2.2E+00	c	2.30E+00	NA	7.92E+06	T	7.92E+06
Trichloromonofluoromethane	75-69-4	7.30E+02	nc	7.30E+02	nc	7.30E+02	NA	2.81E+06	T	2.81E+06
Vinylidene chloride	75-35-4	NA		NA		NA	NA	7.92E+04	T	7.92E+04
Methylene chloride	75-09-2	4.10E+00	c	3.8E+00	c	4.10E+00	6.96E+05	6.94E+05	E	6.96E+05

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
Allyl chloride	107-05-1	1.00E+00	nc	NA		1.00E+00	9.39E+03	9.39E+03	E	9.39E+03
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	3.13E+04	nc	3.14E+04	nc	3.13E+04	NA	9.58E+06	T	9.58E+06
1,1-Dichloroethane	75-34-3	5.21E+02	nc	5.11E+02	nc	5.21E+02	NA	1.21E+06	T	1.21E+06
1,2-Dichloroethene	540-59-0	NA		3.29E+01	nc	3.29E+01	NA	2.38E+06	T	2.38E+06
Chloroform	67-66-3	8.40E-02	c	2.2E+00	c	8.40E-02	NA	9.76E+03	T	9.76E+03
1,2-Dichloroethane	107-06-2	7.39E-02	c	6.88E-02	c	7.39E-02	NA	8.08E+03	T	8.08E+03
Methylchloroform	71-55-6	1.00E+03	nc	2.3E+03	nc	1.00E+03	NA	1.91E+06	T	1.91E+06
Benzene	71-43-2	2.50E-01	c	2.2E-01	c	2.50E-01	NA	1.60E+05	T	1.60E+05
Carbontetrachloride	56-23-5	1.04E+03	nc	1.04E+03	nc	1.04E+03	1.28E+05	1.26E+05	E	1.28E+05
1,2-Dichloropropane	78-87-5	9.89E-02	c	9.21E-02	c	9.89E-02	NA	5.08E+05	T	5.08E+05
Trichloroethylene	79-01-6	1.12E+00	c	1.04E+00	c	1.12E+00	NA	5.37E+05	T	5.37E+05
cis 1,3-Dichloro-1-propene	10061-01-5	NA		NA		NA	NA	1.14E+04	T	1.14E+04
trans 1,3-Dichloro-1-propene	10061-02-6	NA		NA		NA	NA	NA		
1,1,2-Trichloroethane	79-00-5	1.20E-01	c	1.12E-01	c	1.20E-01	NA	1.64E+05	T	1.64E+05
Toluene	108-88-3	4.02E+02	nc	4.16E+02	nc	4.02E+02	1.88E+05	1.89E+05	E	1.88E+05
1,2-Dibromoethane	106-93-4	8.73E-03	c	8.24E-03	c	8.73E-03	NA	1.54E+05	T	1.54E+05
Perchloroethylene	127-18-4	3.31E+00	c	3.13E+00	c	3.31E+00	6.89E+05	6.78E+05	E	6.89E+05
Chlorobenzene	108-90-7	6.20E+01	nc	6.2E+01	nc	6.20E+01	NA	1.38E+05	T	1.38E+05
Ethylbenzene	100-41-4	1.10E+03	nc	1.1E+03	nc	1.10E+03	NA	4.34E+03	T	4.34E+03
m&p-Xylene	108-38-3	7.30E+02	nc	NA		7.30E+02	NA	6.51E+05	T	6.51E+05
Styrene	100-42-5	1.06E+03	nc	1.04E+03	nc	1.06E+03	2.13E+05	2.13E+05	E	2.13E+05
1,1,2,2-Tetrachloroethane	79-34-5	3.31E-02	c	3.13E-02	c	3.31E-02	NA	2.06E+04	T	2.06E+04
o-Xylene	95-47-6	7.30E+02	nc	7.3E+03	nc	7.30E+02	NA	6.51E+05	T	6.51E+05
p-Ethyltoluene	622-96-8	NA		NA		NA	NA	1.25E+05	T	1.25E+05
1,3,5-Trimethylbenzene	108-67-8	6.21E+00	nc	6.21E+00	nc	6.21E+00	NA	3.68E+05	T	3.68E+05
1,2,4-Trimethylbenzene	95-63-6	6.21E+00	nc	6.21E+00	nc	6.21E+00	NA	1.80E+05	T	1.80E+05
Benzylchloride	100-44-7	4.00E-02	nc	3.7E-02	c	4.00E-02	5.20E+03	5.17E+03	E	5.20E+03
m-Dichlorobenzene	541-73-1	3.30E+00	nc	3.3E+00	nc	3.30E+00	NA	3.61E+04	T	3.61E+04
p-Dichlorobenzene	106-46-7	2.80E-01	c	2.85E-01	c	2.80E-01	NA	6.61E+05	T	6.61E+05
o-Dichlorobenzene	95-50-1	2.09E+02	nc	3.29E+01	nc	2.09E+02	NA	3.01E+05	T	3.01E+05
1,2,4-Trichlorobenzene	120-82-1	NA		NA		NA	NA	3.71E+04	T	3.71E+04
Hexachlorobutadiene	87-68-3	8.73E-02	c	8.03E-02	c	8.73E-02	3.21E+04	3.20E+04	E	3.21E+04
trans-1,2-Dichloroethene	156-60-5	7.30E+01	nc	7.3E+01	nc	7.30E+01	NA	4.95E+04	T	4.95E+04
o-Chlorotoluene	95-49-8	7.30E+01	nc	7.3E+01	nc	7.30E+01	NA	3.88E+05	T	3.88E+05
p-Chlorotoluene	106-43-4	NA		NA		NA	NA	3.88E+05	T	3.88E+05
1,3,5-Trichlorobenzene	108-70-3	NA		NA		NA	NA	NA		
1,2,3-Trichlorobenzene	87-61-6	NA		NA		NA	NA	5.00E+04	T	5.00E+04
Methylnitrite	624-91-9	NA		NA		NA	NA	NA		
Acetonitrile	75-05-8	6.20E+01	nc	6.2E+01	nc	6.20E+01	NA	1.01E+05	T	1.01E+05

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
Acrylonitrile	107-13-1	2.80E-02	c	2.6E-02	c	2.80E-02	2.20E+04	2.17E+04	E	2.20E+04
Nitromethane	75-52-5	NA		NA		NA	NA	1.50E+05	T	1.50E+05
Benzonitrile	100-47-0	NA		NA		NA	NA	1.50E+04	T	1.50E+04
Nitrobenzene	98-95-3	2.09E+00	nc	2.19E+00	nc	2.09E+00	NA	1.51E+04	T	1.51E+04
Carbonyl Sulfide	463-58-1	NA		NA		NA	NA	9.84E+03	T	9.84E+03
Sulfur Dioxide	7446-09-5	NA		NA		NA	7.80E+02	7.86E+02	E	7.80E+02
Carbon Disulfide	75-15-0	7.30E+02	nc	7.3E+02	nc	7.30E+02	NA	3.73E+04	T	3.73E+04
Thiophene	110-02-1	NA		NA		NA	NA	NA		
Dimethyldisulfide	624-92-0	NA		NA		NA	4.00E+01	3.85E+01	E	4.00E+01
2-Methylthiophene	554-14-3	NA		NA		NA	NA	NA		
3-Methylthiophene	616-44-4	NA		NA		NA	NA	NA		
Dimethyltrisulfide	3658-80-8	NA		NA		NA	NA	NA		
Isothiocyanatomethane	556-61-6	NA		NA		NA	NA	NA		
2-Chlorothiophene	96-43-5	NA		NA		NA	NA	NA		
3-Chlorothiophene	17249-80-8	NA		NA		NA	NA	NA		
2-Thiophenecarboxaldehyde	98-03-3	NA		NA		NA	NA	NA		
Naphthalene	91-20-3	3.13E+00	nc	3.29E+00	nc	3.13E+00	NA	7.86E+04	T	7.86E+04
Acetaldehyde	75-07-0	8.70E-01	c	8.1E-01	c	8.70E-01	1.80E+04	1.80E+04	E	1.80E+04
Acrolein	107-02-8	2.10E-02	nc	2.1E-02	nc	2.10E-02	2.30E+02	2.29E+03	E	2.30E+02
Acetone	67-64-1	3.40E+02	nc	3.7E+02	nc	3.40E+02	NA	2.37E+06	T	2.37E+06
Propanal	123-38-6	NA		NA		NA	NA	7.50E+04	T	7.50E+04
Furan	110-00-9	3.70E+00	nc	NA		3.70E+00	NA	1.67E+02	T	1.67E+02
2-Propanol	67-63-0	NA		NA		NA	NA	9.84E+05	T	9.84E+05
2-Methylpropanal	78-84-2	NA		NA		NA	NA	NA		
Methacrolein	78-85-3	NA		NA		NA	NA	NA		
2,3-Butanedione	625-34-3	NA		NA		NA	NA	NA		
Methyl-Vinyl Ketone	78-94-4	NA		NA		NA	NA	8.61E+01	T	8.61E+01
MTBE	1634-04-4	3.10E+03	nc	3.1E+03	nc	3.10E+03	NA	4.32E+05	T	4.32E+05
Butanal	123-72-8	NA		NA		NA	NA	7.38E+04	T	7.38E+04
2-Butanone	78-93-3	1.00E+03	nc	1.0E+03	nc	1.00E+03	NA	8.85E+05	T	8.85E+05
Tetrahydrofuran	109-99-9	9.89E-01	nc	9.21E-01	c	9.89E-01	NA	7.38E+05	T	7.38E+05
2-Methyl-1-propanol	78-83-1	1.10E+03	nc	1.1E+03	nc	1.10E+03	NA	4.55E+05	T	4.55E+05
trans-2-Butenal	123-73-9	3.54E-03	c	3.30E-03	c	3.54E-03	NA	NA		
Acetic Acid	64-19-7	NA		NA		NA	NA	3.68E+04	T	3.68E+04
2-Pentanone	107-87-9	NA		NA		NA	NA	8.80E+05	T	8.80E+05
Pentanal	110-62-3	NA		NA		NA	NA	NA		
4-Methyl-2-pentanone	108-10-1	8.30E+01	nc	7.3E+01	nc	8.30E+01	NA	3.07E+05	T	3.07E+05
trans-2-Pentenal	1567-87-0	NA		NA		NA	NA	NA		
Cyclopentanone	120-92-3	NA		NA		NA	NA	NA		

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
2-Hexanone	591-78-6	NA		5.1E+00	nc	5.11E+00	NA	4.09E+04	T	4.09E+04
Hexanal	66-25-1	NA		NA		NA	NA	NA		
3-Furaldehyde	498-60-2	NA		NA		NA	NA	NA		
Butyl Acetate	123-86-4	NA		NA		NA	NA	NA		
2-Furaldehyde	98-01-1	5.20E+01	nc	3.7E+01	nc	5.20E+01	NA	7.86E+03	T	7.86E+03
trans-2-Hexenal	6728-26-3	NA		NA		NA	NA	NA		
1-Hexanol	111-27-3	NA		NA		NA	NA	8.36E+03	T	8.36E+03
3-Heptanone	106-35-4	NA		NA		NA	NA	NA		
2-Heptanone	110-43-0	NA		NA		NA	NA	1.70E+03	T	1.70E+03
Heptanal	66-25-1	NA		NA		NA	NA	NA		
trans-2-Heptenal	18829-55-5	NA		NA		NA	NA	NA		
5-Methyl-2-furaldehyde	620-02-0	NA		NA		NA	NA	NA		
6-Methyl-2-heptanone	928-68-7	NA		NA		NA	NA	NA		
Benzaldehyde	100-52-7	3.70E+02	nc	3.7E+02	nc	3.70E+02	NA	1.50E+04	T	1.50E+04
1-Heptanol	111-70-6	NA		NA		NA	NA	NA		
6-Methyl-5-hepten-2-one	110-93-0	NA		NA		NA	NA	NA		
2-Octanone	111-13-7	NA		NA		NA	NA	NA		
Octanal	124-13-0	NA		NA		NA	NA	NA		
Benzofuran	271-89-6	NA		NA		NA	NA	NA		
trans-2-Octenal	2548-87-0	NA		NA		NA	NA	NA		
Acetophenone	98-86-2	2.10E-02	nc	2.1E-02	nc	2.10E-02	NA	3.00E+04	T	3.00E+04
2-Nonanone	821-55-6	NA		NA		NA	NA	NA		
Nonanal	124-19-6	NA		NA		NA	NA	NA		
trans-2-Nonenal	18829-56-6	NA		NA		NA	NA	NA		
2-Decanone	693-54-9	NA		NA		NA	NA	NA		
Decanal	112-31-2	NA		NA		NA	NA	NA		
N-Nitrosodimethylamine	62-75-9	1.40E-04	c	1.2E-04	c	1.40E-04	NA	2.50E+03	T	2.50E+03
Pyridine	110-86-1	3.65E+00	nc	3.65E+00	nc	3.65E+00	NA	4.85E+04	T	4.85E+04
2-Picoline	109-06-8	NA		NA		NA	NA	NA		
Methyl methanesulfonate	66-27-3	NA		NA		NA	NA	NA		
N-Nitrosomethylethylamine	10595-95-6	3.06E-04	c	2.85E-04	c	3.06E-04	NA	NA		
N-Nitrosodiethylamine	55-18-5	4.47E-05	c	4.17E-05	c	4.47E-05	NA	NA		
Ethyl methanesulfonate	62-50-0	NA		NA		NA	NA	NA		
Phenol	108-95-2	2.19E+03	nc	2.19E+03	nc	2.19E+03	3.85E+05	3.85E+04	E	3.85E+05
Aniline	62-53-3	NA		1.1E+00	nc	1.06E+00	NA	2.29E+04	T	2.29E+04
bis(2-Chloroethyl)ether	111-44-4	5.80E-03	c	5.7E-03	c	5.80E-03	NA	5.85E+04	T	5.85E+04
Pentachloroethane	76-01-7	NA		NA		NA	NA	NA		
2-Chlorophenol	95-57-8	1.80E+01	nc	1.8E+01	nc	1.80E+01	NA	5.25E+03	T	5.25E+03
1,3-Dichlorobenzene	543-73-1	NA		NA		NA	NA	NA		

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
1,4-Dichlorobenzene	106-46-7	2.80E-01	c	2.85E-01	c	2.80E-01	NA	6.61E+05	T	6.61E+05
Benzyl alcohol	100-51-6	1.10E+03	nc	1.1E+03	nc	1.10E+03	NA	5.53E+04	T	5.53E+04
2-Methylphenol	95-48-7	NA		NA		NA	NA	6.63E+04	T	6.63E+04
1,2-Dichlorobenzene	95-50-1	2.09E+02	nc	3.29E+01	nc	2.09E+02	NA	3.01E+05	T	3.01E+05
bis(2-Chloroisopropyl)ether	108-60-1	1.92E-01	c	1.79E-01	c	1.92E-01	NA	6.99E+04	T	6.99E+04
o-Toluidine	95-53-4	2.80E-02	c	2.6E-02	c	2.80E-02	NA	2.63E+04	T	2.63E+04
4-Methylphenol/3-Methylphenol	1319-77-3	NA		NA		NA	NA	6.63E+04	T	6.63E+04
N-Nitroso-di-n-propylamine	621-64-7	9.61E-04	c	8.94E-04	c	9.61E-04	NA	5.32E+03	T	5.32E+03
Acetophenone	98-86-2	2.10E-02	nc	2.1E-02	nc	2.10E-02	NA	1.47E+05	T	1.47E+05
N-Nitrosomorpholine	59-89-2	NA		NA		NA	NA	3.00E+04	T	3.00E+04
N-Nitrosopyrrolidine	930-55-2	3.15E-03	c	3.0E-03	c	3.15E-03	NA	NA		
Hexachloroethane	67-72-1	4.80E-01	c	4.47E-01	c	4.80E-01	NA	2.90E+04	T	2.90E+04
Nitrobenzene	98-95-3	2.09E+00	nc	2.19E+00	nc	2.09E+00	NA	1.51E+04	T	1.51E+04
N-Nitrosopiperidine	100-75-4	NA		NA		NA	NA	NA		
Isophorone	78-59-1	7.08E+00	c	6.59E+00	c	7.08E+00	NA	2.83E+04	T	2.83E+04
2,4-Dimethylphenol	105-67-9	7.30E+01	nc	7.3E+01	nc	7.30E+01	NA	NA		
2-Nitrophenol	88-75-5	NA		NA		NA	NA	NA		
bis(2-Chloroethoxy)methane	111-91-1	NA		NA		NA	NA	NA		
Benzoic acid	65-85-0	1.50E+04	nc	1.5E+04	nc	1.50E+04	NA	1.25E+04	T	1.25E+04
2,4-Dichlorophenol	120-83-2	1.10E+01	nc	1.1E+01	nc	1.10E+01	NA	3.00E+04	T	3.00E+04
1,2,4-Trichlorobenzene	120-82-1	NA		NA		NA	NA	3.71E+04	T	3.71E+04
Naphthalene	91-20-3	3.13E+00	nc	3.29E+00	nc	3.13E+00	NA	7.86E+04	T	7.86E+04
p-Chloroaniline	106-47-8	1.46E+01	nc	1.46E+01	nc	1.46E+01	NA	5.21E+03	T	5.21E+03
2,6-Dichlorophenol	87-65-0	NA		NA		NA	NA	3.00E+04	T	3.00E+04
Hexachloropropene	1888-71-7	NA		NA		NA	NA	NA		
Hexachlorobutadiene	87-68-3	8.73E-02	c	8.03E-02	c	8.73E-02	3.21E+04	3.20E+04	E	3.21E+04
Dimethylphenethylamine		NA		NA		NA	NA	NA		
N-Nitroso-di-n-butylamine	924-16-3	1.20E-03	c	1.12E-03	c	1.20E-03	NA	NA		
4-Chloro-3-methylphenol	35421-08-0	NA		NA		NA	NA	NA		
Safrole	94-59-7	NA		NA		NA	NA	NA		
2-Methylnaphthalene	91-57-6	NA		NA		NA	NA	2.00E+04	T	2.00E+04
1,2,4,5-Tetrachlorobenzene	95-94-3	1.10E+00	nc	1.10E+00	nc	1.10E+00	NA	3.00E+04	T	3.00E+04
Hexachlorocyclopentadiene	77-47-4	7.30E-02	nc	7.30E-02	nc	7.30E-02	NA	2.23E+02	T	2.23E+02
2,4,6-Trichlorophenol	88-06-2	6.20E-01	c	6.3E-01	c	6.20E-01	NA	3.00E+04	T	3.00E+04
2,4,5-Trichlorophenol	95-95-4	3.70E+02	nc	3.7E+02	nc	3.70E+02	NA	3.00E+04	T	3.00E+04
Isosafrole	120-58-1	NA		NA		NA	NA	NA		
2-Chloronaphthalene	91-58-7	2.90E+02	nc	2.9E+02	nc	2.90E+02	NA	6.00E+02	T	6.00E+02
2-Nitroaniline	88-74-4	2.10E-01	nc	2.1E-01	nc	2.10E-01	NA	NA		
1,4-Naphthoquinone	130-15-4	NA		NA		NA	NA	2.50E+02	T	2.50E+02

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

		For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
Compound	CAS #	Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
Dimethylphthalate	131-11-3	3.65E+04	nc	3.65E+04	nc	3.65E+04	NA	1.50E+04	T	1.50E+04
1,3-Dinitrobenzene	99-65-0	3.70E-01	nc	3.7E-01	nc	3.70E-01	NA	3.00E+03	T	3.00E+03
2,6-Dinitrotoluene	606-20-2	3.70E+00	nc	3.7E+00	nc	3.70E+00	NA	6.00E+02	T	6.00E+02
Acenaphthylene	208-96-8	NA		NA		NA	NA	2.00E+02	T	2.00E+02
3-Nitroaniline	99-09-2	NA		NA		NA	NA	NA		
4-Nitrophenol	100-02-7	2.90E+01	nc	2.9E+01	nc	2.90E+01	NA	3.00E+04	T	3.00E+04
2,4-Dinitrophenol	51-28-5	7.30E+00	nc	7.3E+00	nc	7.30E+00	NA	7.50E+03	T	7.50E+03
Acenaphthene	83-32-9	2.20E+02	nc	2.2E+02	nc	2.20E+02	NA	1.25E+03	T	1.25E+03
2,4-Dinitrotoluene	121-14-2	7.30E+00	nc	7.3E+00	nc	7.30E+00	NA	6.00E+02	T	6.00E+02
Dibenzofuran	132-64-9	1.46E+01	nc	1.46E+01	nc	1.46E+01	NA	1.50E+00	T	1.50E+00
Pentachlorobenzene	608-93-5	2.92E+00	nc	2.92E+00	nc	2.92E+00	NA	3.00E+04	T	3.00E+04
1-Naphthylamine	134-32-7	NA		NA		NA	NA	3.50E+04	T	3.50E+04
2-Naphthylamine	91-59-8	NA		NA		NA	NA	7.50E+03	T	7.50E+03
2,3,4,6-Tetrachlorophenol	58-90-2	1.10E+02	nc	1.1E+02	nc	1.10E+02	NA	NA		
Diethylphthalate	84-66-2	2.92E+03	nc	2.92E+03	nc	2.92E+03	NA	1.50E+04	T	1.50E+04
4-Chlorophenylphenyl ether	7005-72-3	NA		NA		NA	NA	NA		
Fluorene	86-73-7	1.46E+02	nc	1.46E+02	nc	1.46E+02	NA	7.50E+04	T	7.50E+04
5-Nitro-o-toluidine	99-55-8	2.00E-01	c	1.9E-01	c	2.00E-01	NA	NA		
4-Nitroaniline	100-01-6	NA		NA		NA	NA	9.00E+03	T	9.00E+03
4,6-Dinitro-2-methylphenol	534-52-1	NA		3.7E-01	nc	3.65E-01	NA	5.00E+02	T	5.00E+02
Diphenylamine/N-NitrosoDPA	62-75-9	NA		NA		NA	NA	2.50E+03	T	2.50E+03
sym-Trinitrobenzene	99-35-4	1.10E+02	nc	1.10E+02	nc	1.10E+02	NA	3.00E+04	T	3.00E+04
Diallate	2303-16-4	1.10E-01	c	NA		1.10E-01	NA	NA		
Phenacetin	62-44-2	NA		NA		NA	NA	3.00E+04	T	3.00E+04
4-Bromophenylphenyl ether	101-55-3	NA		NA		NA	NA	NA		
Hexachlorobenzene	118-74-1	4.18E-03	c	3.91E-03	c	4.18E-03	NA	7.50E+01	T	7.50E+01
4-Aminobiphenyl	92-67-1	NA		NA		NA	NA	1.50E+03	T	1.50E+03
Pronamide	23950-58-5	2.74E+02	nc	NA		2.74E+02	NA	NA		
Pentachlorophenol	87-86-5	5.60E-02	c	5.22E-02	c	5.60E-02	NA	1.50E+03	T	1.50E+03
Pentachloronitrobenzene	82-68-8	2.59E-02	c	2.41E-02	c	2.59E-02	NA	1.50E+03	T	1.50E+03
Phenanthrene	85-01-8	NA		NA		NA	NA	2.00E+03	T	2.00E+03
Anthracene	120-12-7	1.10E+03	nc	1.1E+03	nc	1.10E+03	NA	6.00E+03	T	6.00E+03
Carbazole	86-74-8	3.36E-01	c	3.13E-01	c	3.36E-01	NA	NA		
Di-n-butylphthalate	84-74-2	3.65E+02	nc	3.65E+02	nc	3.65E+02	NA	1.50E+04	T	1.50E+04
4-Nitroquinoline-1-oxide	56-57-5	NA		NA		NA	NA	NA		
Methapyrilene	91-80-5	NA		NA		NA	NA	NA		
Fluoranthene	206-44-0	1.50E+02	nc	1.5E+02	nc	1.50E+02	NA	3.00E+01	T	3.00E+01
Benzidine	92-87-5	2.90E-05	c	NA		2.90E-05	NA	5.00E+02	T	5.00E+02
Pyrene	129-00-0	NA		NA		NA	NA	1.50E+04	T	1.50E+04

Appendix C: Health-Based Screening Levels and Acute Toxicity Values

Compound	CAS #	For the Chronic Evaluation (HBSL)					For the Acute Evaluation (ATV)			
		Region 9 PRG ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Region 3 RBC ($\mu g/m^3$)	Toxicity Endpoint (c or nc)	Health-based Screening Level ($\mu g/m^3$)	ERPG ($\mu g/m^3$)	TEEL ($\mu g/m^3$)	Source (T or E)	Acute Toxicity Value ($\mu g/m^3$)
p-Dimethylaminoazobenzene	60-11-7	NA		NA		NA	NA	7.50E+04	T	7.50E+04
Chlorobenzilate	510-15-6	2.49E-02	c	2.32E-02	c	2.49E-02	NA	2.50E+02	T	2.50E+02
Kepone	143-50-0	3.74E-04	c	NA		3.74E-04	NA	1.00E+02	T	1.00E+02
Butylbenzylphthalate	85-68-7	7.30E+02	nc	7.30E+02	nc	7.30E+02	NA	5.00E+05	T	5.00E+05
3,3'-Dimethylbenzidine	119-93-7	7.30E-04	c	6.8E-04	c	7.30E-04	NA	3.00E+00	T	3.00E+00
2-Acetylaminofluorene	53-96-3	NA		NA		NA	NA	2.50E+03	T	2.50E+03
bis(2-Ethylhexyl)phthalate	117-81-7	4.80E-01	c	4.47E-01	c	4.80E-01	NA	1.00E+04	T	1.00E+04
3,3'-Dichlorobenzidine	91-94-1	1.50E-02	c	1.4E-02	c	1.50E-02	NA	6.21E+03	T	6.21E+03
Benz(a)anthracene	56-55-3	2.20E-02	c	8.6E-03	c	2.20E-02	NA	6.00E+02	T	6.00E+02
Chrysene	218-01-9	2.17E+00	c	8.58E-01	c	2.17E+00	NA	2.00E+02	T	2.00E+02
Di-n-octylphthalate	117-84-0	7.30E+01	nc	7.30E+01	nc	7.30E+01	NA	1.50E+05	T	1.50E+05
7,12-Dimethylbenz(a)anthracene	57-97-6	NA		NA		NA	NA	NA		
Benzo(b)fluoranthene	205-99-2	2.20E-02	c	8.6E-03	c	2.20E-02	NA	NA		
Benzo(k)fluoranthene	207-08-9	2.20E-01	c	8.6E-02	c	2.20E-01	NA	NA		
Benz(a)pyrene	50-32-8	2.20E-03	c	2.0E-03	c	2.20E-03	NA	7.50E+03	T	7.50E+03
3-Methylcholanthrene	56-49-5	NA		NA		NA	NA	1.50E+03	T	1.50E+03
Indeno(1,2,3-cd)pyrene	193-39-5	2.17E-02	c	8.58E-03	c	2.17E-02	NA	NA		
Dibenz(a,h)anthracene	53-70-3	2.17E-03	c	8.58E-04	c	2.17E-03	NA	3.00E+04	T	3.00E+04
Benzo(g,h,i)perylene	191-24-2	NA		NA		NA	NA	3.00E+04	T	3.00E+04

Footnotes:
PRG: Preliminary Remediation Goals
c: Cancer
nc:non-cancer
RBC: Risk-Based Concentration
HBSL: Health-based Screening Level
(E) ERPG: Emergency Response Planning Guidelines
(T) TEEL: Temporary Emergency Exposure Limits
ATV: Acute Toxicity Value
NA: Not available

APPENDIX D

RISK EVALUATION DATA

Table D-1: Comparison of Air Concentrations With Health-Based Values: Metals, Particulates and Miscellaneous Compounds

	Red Star Cluster Signal Flare							
Compound	**$C_{chronic}$ (µg/m^3)**	**Health-Based Screening Level (µg/m^3)**	**$C_{chronic}$/ HBSL**	**> 1?**	**C_{acute} (µg/m^3)**	**Acute Toxicity Value (µg/m^3)**	**C_{acute}/ ATV**	**> 1?**
TSP	3.03E-02	5.00E+01	6.07E-04	no	NA	NA		na
PM_{10}	2.74E-02	5.00E+01	5.49E-04	no	NA	NA		na
HCl (a)	5.43E-05	2.08E+01	2.61E-06	no	3.81E-01	7.14E+03	5.33E-05	no
Cl_2 (a)	2.47E-07	2.09E-01	1.18E-06	no	4.32E-04	2.89E+03	1.50E-07	no
Dioxin TEQ (b)	NA	4.48E-08		na	NA	3.50E+00		na
Carbon Monoxide (CO)	2.63E-03	1.57E+02	1.67E-05	no	4.60E+00	2.30E+05	2.00E-05	no
Nitrogen Oxide (NOx)	1.07E-03	1.00E+02	1.07E-05	no	7.49E+00	2.70E+05	2.77E-05	no
HCl (a)	NA	2.08E+01		na	NA	7.14E+03		na
Carbon Dioxide (CO_2)	5.89E-02	NV		na	4.13E+02	5.40E+07	7.65E-06	no
Sulfur Dioxide (SO_2)	4.16E-05	8.00E+01	5.19E-07	no	7.28E-02	7.89E+02	9.22E-05	no
Aluminum	2.69E-05	3.65E+00	7.37E-06	no	1.89E-01	3.00E+04	6.29E-06	no
Antimony	NA	1.46E+00		na	NA	1.50E+03		na
Arsenic	NA	4.47E-04		na	NA	3.00E+01		na
Barium	3.79E-05	5.21E-01	7.26E-05	no	2.65E-01	1.50E+03	1.77E-04	no
Beryllium	NA	8.00E-04		na	NA	5.00E+00		na
Cadmium	9.02E-08	1.07E-03	8.46E-05	no	1.48E-03	3.00E+01	4.92E-05	no
Chromium	1.45E-07	1.53E-04	9.52E-04	no	2.38E-03	1.50E+03	1.58E-06	no
Cobalt	6.53E-08	2.20E+02	2.97E-10	no	4.57E-04	6.00E+01	7.62E-06	no
Copper	1.34E-06	1.46E+02	9.20E-09	no	9.41E-03	3.00E+03	3.14E-06	no
Lead	5.79E-07	1.50E+00	3.86E-07	no	4.06E-03	1.50E+02	2.71E-05	no
Magnesium	1.11E-02	NV		na	7.79E+01	3.00E+04	2.60E-03	no
Manganese	4.45E-07	5.11E-02	8.72E-06	no	3.12E-03	3.00E+03	1.04E-06	no
Nickel	2.01E-07	7.30E+01	2.75E-09	no	1.41E-03	3.00E+03	4.70E-07	no
Phosphorus	6.69E-07	NV		na	4.69E-03	3.00E+02	1.56E-05	no
Selenium	NA	1.83E+01		na	NA	6.00E+02		na
Silver	NA	1.83E+01		na	NA	3.00E+02		na
Thallium	NA	2.56E-01		na	NA	3.00E+02		na
Zinc	NA	1.10E+03		na	NA	3.00E+04		na
Mercury	3.22E-14	3.13E-01	1.03E-13	no	2.25E-04	1.00E+02	2.25E-06	no

Footnote:
(a) HCl/Cl_2 levels were too low to be reliably measured.
(b) Presence questionable - reported at similar levels in samples and blanks.
NA = Not applicable because compound was not detected.
na = Not available because health-based screening value is not available or not applicable if compound was not detected.
NV = No value
$C_{chronic}$ = Chronic time-averaged concentration ; HBSL = Chronic health-based screening level
>1? = Is the ratio greater than one?
C_{acute} = Acute concentration; ATV = Acute toxicity value

Table D-2: Comparison of Air Concentrations With Health-Based Values: Volatile Organic Compounds								
	Red Star Cluster Signal Flare							
Compound (a)	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
Total Nonmethane Hydrocarbons (TNMHC)								
TNMHC	9.20E-05	NV		na	NA	NA		na
Volatile Organic Compounds (VOCs)								
Ethane	5.85E-06	NV		na	NA	NA		na
Ethylene	1.65E-05	NV		na	1.16E-01	4.60E+05	2.52E-07	no
Acetylene	1.01E-05	NV		na	NA	NA		na
Propane	1.22E-06	NV		na	8.58E-03	3.78E+06	2.27E-09	no
Propene	6.89E-06	NV		na	NA	NA		na
i-Butane	3.83E-08	NV		na	2.68E-04	5.71E+06	4.69E-11	no
i-Butene	4.59E-07	NV		na	NA	NA		na
1-Butene	1.03E-06	NV		na	NA	NA		na
1,3-Butadiene	3.94E-07	3.74E-03	1.05E-04	no	1.61E-03	2.20E+04	7.31E-08	no
n-Butane	3.06E-07	NV		na	2.15E-03	5.71E+06	3.76E-10	no
trans-2-Butene	8.80E-07	NV		na	NA	NA		na
2,2-Dimethylpropane	NA	NV		na	NA	NA		na
cis-2-Butene	3.44E-07	NV		na	NA	NA		na
3-Methyl-1-butene	NA	NV		na	NA	NA		na
i-Pentane	4.59E-07	NV		na	3.22E-03	1.80E+06	1.79E-09	no
1-Pentene	3.83E-07	NV		na	NA	NA		na
2-Methyl-1-butene	2.68E-07	NV		na	NA	NA		na
n-Pentane	1.42E-06	NV		na	9.92E-03	1.80E+06	5.51E-09	no
Isoprene	1.53E-07	NV		na	NA	NA		na
trans-2-Pentene	4.21E-07	NV		na	NA	NA		na
cis-2-Pentene	7.65E-08	NV		na	NA	NA		na
2-Methyl-2-butene	1.53E-07	NV		na	NA	NA		na
2,2-Dimethylbutane	NA	NV		na	NA	1.80E+06		na
Cyclopentene	7.65E-08	NV		na	NA	NA		na
4-Methyl-1-pentene	NA	NV		na	NA	NA		na
Cyclopentane	NA	NV		na	NA	NA		na
2,3-Dimethylbutane	NA	NV		na	NA	NA		na
cis-4-Methyl-2-pentene	NA	NV		na	NA	NA		na

Table D-2: Comparison of Air Concentrations With Health-Based Values: Volatile Organic Compounds

	Red Star Cluster Signal Flare							
Compound (a)	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
2-Methylpentane	1.91E-07	NV		na	1.34E-03	1.80E+06	7.47E-10	no
3-Methylpentane	3.06E-07	NV		na	NA	NA		na
2-Methyl-1-pentene	NA	NV		na	NA	NA		na
1-Hexene	3.83E-07	NV		na	2.68E-03	1.03E+05	2.60E-08	no
n-Hexane	1.91E-07	2.10E+02	9.11E-10	no	1.34E-03	5.28E+05	2.54E-09	no
trans-2-Hexene	NA	NV		na	NA	NA		na
2-Methyl-2-pentene	NA	NV		na	NA	NA		na
cis-2-Hexene	NA	NV		na	NA	NA		na
Methylcyclopentane	NA	NV		na	NA	NA		na
2,4-Dimethylpentane	NA	NV		na	NA	NA		na
Benzene	3.15E-06	2.50E-01	1.26E-05	no	1.29E-02	1.56E+05	8.25E-08	no
Cyclohexane	NA	NV		na	NA	3.10E+06		na
2-Methylhexane	7.65E-08	NV		na	NA	NA		na
2,3-Dimethylpentane	2.30E-07	NV		na	NA	NA		na
3-Methylhexane	0.00E+00	NV		na	NA	NA		na
2,2,4-Trimethylpentane	4.21E-07	NV		na	2.95E-03	3.50E+05	8.43E-09	no
n-Heptane	NA	NV		na	NA	1.80E+06		na
2,4,4-Trimethyl-1-pentene	NA	NV		na	NA	NA		na
Methylcyclohexane	NA	3.10E+03		na	NA	4.81E+06		na
2,4,4-Trimethyl-2-pentene	NA	NV		na	NA	NA		na
2,5-Dimethylhexane	NA	NV		na	NA	NA		na
2,4-Dimethylhexane	NA	NV		na	NA	NA		na
2,3,4-Trimethylpentane	3.83E-08	NV		na	NA	NA		na
Toluene	2.64E-06	4.02E+02	6.58E-09	no	4.63E-03	1.88E+05	2.47E-08	no
2,3-Dimethylhexane	NA	NV		na	NA	NA		na
2-Methylheptane	NA	NV		na	NA	NA		na
3-Ethylhexane	NA	NV		na	NA	NA		na
2,2-Dimethylheptane	NA	NV		na	NA	NA		na
2,2,4-Trimethylhexane	NA	NV		na	NA	NA		na
n-Octane	1.53E-07	NV		na	NA	NA		na
Ethylcyclohexane	NA	NV		na	NA	NA		na

Table D-2: Comparison of Air Concentrations With Health-Based Values: Volatile Organic Compounds								
	Red Star Cluster Signal Flare							
Compound (a)	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
Ethylbenzene	1.03E-06	1.10E+03	9.39E-10	no	7.24E-03	5.43E+05	1.33E-08	no
m-Xylene & p-Xylene	2.83E-06	NV		na	1.98E-02	6.51E+05	3.05E-08	no
Styrene	7.65E-07	1.10E+03	6.96E-10	no	1.34E-03	2.13E+05	6.29E-09	no
o-Xylene	9.57E-07	7.30E+03	1.31E-10	no	6.70E-03	6.51E+05	1.03E-08	no
n-Nonane	9.18E-07	4.02E+02	2.29E-09	no	6.44E-03	1.05E+06	6.14E-09	no
i-Propylbenzene	NA	4.00E+02		na	NA	NA		na
n-Propylbenzene	3.83E-08	3.65E+01	1.05E-09	no	NA	NA		na
p-Ethyltoluene	1.91E-07	NV		na	1.34E-03	1.25E+05	1.07E-08	no
m-Ethyltoluene	3.83E-08	NV		na	NA	NA		na
1,3,5-Trimethylbenzene	7.65E-08	6.20E+00	1.23E-08	no	5.36E-04	3.68E+05	1.46E-09	no
o-Ethyltoluene	NA	NV		na	NA	7.50E+02		na
1,2,4-Trimethylbenzene & sec-Butylbenzene	1.15E-07	6.21E+00	1.85E-08	no	8.04E-04	1.80E+05	4.47E-09	no
n-Decane	NA	NV		na	NA	4.37E+03		na
alpha-Pinene	NA	NV		na	NA	4.00E+04		na
beta-Pinene	NA	NV		na	NA	NA		na
delta 3-Carene	NA	NV		na	NA	NA		na
d-Limonene	NA	NV		na	NA	1.95E+06		na
MTBE	3.06E-07	3.10E+03	9.87E-11	no	2.15E-03	4.32E+05	4.97E-09	no
Dichlorodifluoromethane	NA	2.10E+02		na	NA	1.48E+07		na
Methylchloride	NA	NV		na	NA	NA		na
Dichlorotetrafluoroethane	NA	NV		na	NA	NA		na
Chloroethene	NA	2.20E-02		na	NA	1.28E+04		na
1,3-Butadiene	4.00E-07	3.74E-03	1.07E-04	no	1.64E-03	2.20E+04	7.44E-08	no
Methylbromide	NA	5.20E+00		na	NA	5.82E+04		na
Ethylchloride	NA	2.30E+00		na	NA	7.92E+06		na
Trichloromonofluoromethane	6.14E-08	7.30E+02	8.42E-11	no	4.31E-04	2.81E+06	1.53E-10	no
Vinylidenechloride	NA	NV		na	NA	7.92E+04		na
Methylenechloride	NA	4.10E+00		na	NA	6.96E+05		na
Allylchloride	NA	1.00E+00		na	NA	9.39E+03		na
1,1,2-Trichloro-1,2,2-trifluoroethane	2.17E-07	3.13E+04	6.95E-12	no	1.52E-03	9.58E+06	1.59E-10	no

Table D-2: Comparison of Air Concentrations With Health-Based Values: Volatile Organic Compounds

	Red Star Cluster Signal Flare							
Compound (a)	**$C_{chronic}$ (µg/m^3)**	**Health-Based Screening Level (µg/m^3)**	**$C_{chronic}$/ HBSL**	**> 1?**	**C_{acute} (µg/m^3)**	**Acute Toxicity Value (µg/m^3)**	**C_{acute}/ ATV**	**> 1?**
1,1-Dichloroethane	NA	5.21E+02		na	NA	1.21E+06		na
1,2-Dichloroethene	NA	3.29E+01		na	NA	2.38E+06		na
Chloroform	NA	8.40E-02		na	NA	9.76E+03		na
1,2-Dichloroethane	NA	7.39E-02		na	NA	8.08E+03		na
Methylchloroform	2.78E-08	1.00E+03	2.78E-11	no	1.95E-04	1.91E+06	1.02E-10	no
Benzene	3.20E-06	2.50E-01	1.28E-05	no	5.24E-02	1.60E+05	3.28E-07	no
Carbontetrachloride	8.21E-08	1.04E+03	7.88E-11	no	1.44E-04	1.28E+05	1.12E-09	no
1,2-Dichloropropane	NA	9.89E-02		na	NA	5.08E+05		na
Trichloroethylene	NA	1.12E+00		na	NA	5.37E+05		na
cis 1,3-Dichloro-1-propene	NA	NV		na	NA	1.14E+04		na
trans 1,3-Dichloro-1-propene	NA	NV		na	NA	NA		na
1,1,2-Trichloroethane	NA	1.20E-01		na	NA	1.64E+05		na
Toluene	2.69E-06	4.02E+02	6.69E-09	no	4.70E-03	1.88E+05	2.51E-08	no
1,2-Dibromoethane	NA	8.73E-03		na	NA	1.54E+05		na
Perchloroethylene	NA	3.31E+00		na	NA	6.89E+05		na
Chlorobenzene	NA	6.20E+01		na	NA	1.38E+05		na
Ethylbenzene	1.59E-06	1.10E+03	1.44E-09	no	1.11E-02	4.34E+03	2.56E-06	no
m&p-Xylene	2.88E-06	7.30E+02	3.94E-09	no	2.02E-02	6.51E+05	3.10E-08	no
Styrene	7.78E-07	1.06E+03	7.35E-10	no	1.36E-03	2.13E+05	6.40E-09	no
1,1,2,2-Tetrachloroethane	NA	3.31E-02		na	NA	2.06E+04		na
o-Xylene	9.73E-07	7.30E+02	1.33E-09	no	6.82E-03	6.51E+05	1.05E-08	no
p-Ethyltoluene	1.95E-07	NV		na	1.36E-03	1.25E+05	1.09E-08	no
1,3,5-Trimethylbenzene	NA	6.21E+00		na	NA	3.68E+05		na
1,2,4-Trimethylbenzene	1.17E-07	6.21E+00	1.88E-08	no	8.18E-04	1.80E+05	4.55E-09	no
Benzylchloride	NA	4.00E-02		na	NA	5.20E+03		na
m-Dichlorobenzene	NA	3.30E+00		na	NA	3.61E+04		na
p-Dichlorobenzene	NA	2.80E-01		na	NA	6.61E+05		na
o-Dichlorobenzene	NA	2.09E+02		na	NA	3.01E+05		na
1,2,4-Trichlorobenzene	NA	NV		na	NA	3.71E+04		na
Hexachlorobutadiene	NA	8.73E-02		na	NA	3.21E+04		na
trans-1,2-Dichloroethene	NA	7.30E+01		na	NA	4.95E+04		na

Table D-2: Comparison of Air Concentrations With Health-Based Values: Volatile Organic Compounds								
	Red Star Cluster Signal Flare							
Compound (a)	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
o-Chlorotoluene	NA	7.30E+01		na	NA	3.88E+05		na
p-Chlorotoluene	NA	NV		na	NA	3.88E+05		na
1,3,5-Trichlorobenzene	NA	NV		na	NA	NA		na
1,2,3-Trichlorobenzene	NA	NV		na	NA	5.00E+04		na
Methylnitrite	1.44E-06	NV		na	NA	NA		na
Acetonitrile	5.36E-07	6.20E+01	8.64E-09	no	3.75E-03	1.01E+05	3.73E-08	no
Acrylonitrile	2.86E-07	2.80E-02	1.02E-05	no	1.17E-03	2.20E+04	5.32E-08	no
Nitromethane	1.20E-06	NV		na	8.39E-03	1.50E+05	5.59E-08	no
Benzonitrile	2.93E-07	NV		na	2.06E-03	1.50E+04	1.37E-07	no
Nitrobenzene	NA	2.09E+00		na	NA	1.51E+04		na
Carbonyl Sulfide	1.42E-07	NV		na	9.93E-04	9.84E+03	1.01E-07	no
Sulfur Dioxide	NA	NV		na	NA	7.80E+02		na
Carbon Disulfide	4.86E-06	7.30E+02	6.66E-09	no	3.40E-02	3.73E+04	9.12E-07	no
Thiophene	3.42E-07	NV		na	NA	NA		na
Dimethyldisulfide	NA	NV		na	NA	4.00E+01		na
2-Methylthiophene	NA	NV		na	NA	NA		na
3-Methylthiophene	NA	NV		na	NA	NA		na
Dimethyltrisulfide	NA	NV		na	NA	NA		na
Isothiocyanatomethane	NA	NV		na	NA	NA		na
2-Chlorothiophene	NA	NV		na	NA	NA		na
3-Chlorothiophene	NA	NV		na	NA	NA		na
2-Thiophenecarboxaldehyde	NA	NV		na	NA	NA		na
Naphthalene	7.84E-07	3.13E+00	2.51E-07	no	5.50E-03	7.86E+04	6.99E-08	no
Acetaldehyde	1.28E-07	8.70E-01	1.47E-07	no	5.24E-04	1.80E+04	2.91E-08	no
Acrolein	9.61E-07	2.10E-02	4.58E-05	no	1.68E-03	2.30E+02	7.32E-06	no
Acetone	3.38E-06	3.40E+02	9.95E-09	no	2.37E-02	2.37E+06	1.00E-08	no
Propanal	7.29E-07	NV		na	5.11E-03	7.50E+04	6.81E-08	no
Furan	1.14E-06	3.70E+00	3.09E-07	no	8.01E-03	1.67E+02	4.80E-05	no
2-Propanol	NA	NV		na	NA	9.84E+05		na
2-Methylpropanal	NA	NV		na	NA	NA		na
Methacrolein	2.17E-07	NV		na	NA	NA		na

Table D-2: Comparison of Air Concentrations With Health-Based Values: Volatile Organic Compounds								
	Red Star Cluster Signal Flare							
Compound (a)	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
2,3-Butanedione	NA	NV		na	NA	NA		na
Methyl-Vinyl Ketone	2.94E-07	NV		na	2.06E-03	8.61E+01	2.39E-05	no
MTBE	1.71E-07	3.10E+03	5.52E-11	no	1.20E-03	4.32E+05	2.78E-09	no
Butanal	2.62E-09	NV		na	1.83E-05	7.38E+04	2.49E-10	no
2-Butanone	8.19E-07	1.00E+03	8.19E-10	no	5.74E-03	8.85E+05	6.49E-09	no
Tetrahydrofuran	2.47E-07	9.89E-01	2.50E-07	no	1.73E-03	7.38E+05	2.35E-09	no
2-Methyl-1-propanol	NA	1.10E+03		na	NA	4.55E+05		na
trans-2-Butenal	8.48E-08	3.54E-03	2.40E-05	no	NA	NA		na
Acetic Acid	4.50E-07	NV		na	3.16E-03	3.68E+04	8.59E-08	no
2-Pentanone	1.09E-06	NV		na	7.67E-03	8.80E+05	8.71E-09	no
Pentanal	8.48E-08	NV		na	NA	NA		na
4-Methyl-2-pentanone	NA	8.30E+01		na	NA	3.07E+05		na
trans-2-Pentenal	NA	NV		na	NA	NA		na
Cyclopentanone	2.05E-07	NV		na	NA	NA		na
2-Hexanone	1.62E-07	5.11E+00	3.16E-08	no	1.13E-03	4.09E+04	2.77E-08	no
Hexanal	NA	NV		na	NA	NA		na
3-Furaldehyde	NA	NV		na	NA	NA		na
Butyl Acetate	4.14E-07	NV		na	NA	NA		na
2-Furaldehyde	1.90E-06	5.20E+01	3.66E-08	no	1.33E-02	7.86E+03	1.70E-06	no
trans-2-Hexenal	NA	NV		na	NA	NA		na
1-Hexanol	NA	NV		na	NA	8.36E+03		na
3-Heptanone	2.10E-07	NV		na	NA	NA		na
2-Heptanone	NA	NV		na	NA	1.70E+03		na
Heptanal	7.36E-08	NV		na	NA	NA		na
trans-2-Heptenal	NA	NV		na	NA	NA		na
5-Methyl-2-furaldehyde	NA	NV		na	NA	NA		na
6-Methyl-2-heptanone	NA	NV		na	NA	NA		na
Benzaldehyde	8.67E-07	3.70E+02	2.34E-09	no	6.07E-03	1.50E+04	4.05E-07	no
1-Heptanol	NA	NV		na	NA	NA		na
6-Methyl-5-hepten-2-one	NA	NV		na	NA	NA		na
2-Octanone	NA	NV		na	NA	NA		na

Table D-2: Comparison of Air Concentrations With Health-Based Values: Volatile Organic Compounds

	Red Star Cluster Signal Flare							
Compound (a)	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
Octanal	7.41E-07	NV		na	NA	NA		na
Benzofuran	5.86E-07	NV		na	NA	NA		na
trans-2-Octenal	NA	NV		na	NA	NA		na
Acetophenone	3.19E-07	2.10E-02	1.52E-05	no	2.24E-03	3.00E+04	7.45E-08	no
2-Nonanone	NA	NV		na	NA	NA		na
Nonanal	1.18E-06	NV		na	NA	NA		na
trans-2-Nonenal	NA	NV		na	NA	NA		na
2-Decanone	NA	NV		na	NA	NA		na
Decanal	NA	NV		na	NA	NA		na

Footnotes:

(a) Items in bold represent duplicate values for those compounds that are common for Method TO-14 and TO-12.

NA = Not applicable

na = Not available because health-based screening value is not available or not applicable because compound was not detected.

NV = No value

$C_{chronic}$ = Chronic time-averaged concentration

HBSL = Chronic health-based screening level

>1? = Is the ratio greater than one?

C_{acute} = Acute concentration

ATV = Acute toxicity value

Table D-3: Comparison of Air Concentrations With Health-Based Values: Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare							
Compound	**$C_{chronic}$ (µg/m^3)**	**Health-Based Screening Level (µg/m^3)**	**$C_{chronic}$/ HBSL**	**> 1?**	**C_{acute} (µg/m^3)**	**Acute Toxicity Value (µg/m^3)**	**C_{acute}/ ATV**	**> 1?**
Particulate/Vapor-phase SVOCs								
N-Nitrosodimethylamine	NA	1.40E-04		na	NA	2.50E+03		na
Pyridine	NA	3.65E+00		na	NA	4.85E+04		na
2-Picoline	NA	NV		na	NA	NA		na
Methyl methanesulfonate	NA	NV		na	NA	NA		na
N-Nitrosomethylethylamine	NA	3.06E-04		na	NA	NA		na
N-Nitrosodiethylamine	NA	4.47E-05		na	NA	NA		na
Ethyl methanesulfonate	NA	NV		na	NA	NA		na
Phenol	NA	2.19E+03		na	NA	3.85E+05		na
Aniline	NA	1.06E+00		na	NA	2.29E+04		na
bis(2-Chloroethyl)ether	NA	5.80E-03		na	NA	5.85E+04		na
Pentachloroethane	NA	NV		na	NA	NA		na
2-Chlorophenol	NA	1.80E+01		na	NA	5.25E+03		na
1,3-Dichlorobenzene	NA	NV		na	NA	NA		na
1,4-Dichlorobenzene	NA	2.80E-01		na	NA	6.61E+05		na
Benzyl alcohol	NA	1.10E+03		na	NA	5.53E+04		na
2-Methylphenol	NA	NV		na	NA	6.63E+04		na
1,2-Dichlorobenzene	NA	2.09E+02		na	NA	3.01E+05		na
bis(2-Chloroisopropyl)ether	NA	1.92E-01		na	NA	6.99E+04		na
o-Toluidine	NA	2.80E-02		na	NA	2.63E+04		na
4-Methylphenol/3-Methylphenol	NA	NV		na	NA	6.63E+04		na
N-Nitroso-di-n-propylamine	NA	9.61E-04		na	NA	5.32E+03		na
Acetophenone	1.49E-07	2.10E-02	7.09E-06	no	1.04E-03	1.47E+05	7.08E-09	no
N-Nitrosomorpholine	NA	NV		na	NA	3.00E+04		na
N-Nitrosopyrrolidine	NA	3.15E-03		na	NA	NA		na
Hexachloroethane	NA	4.80E-01		na	NA	2.90E+04		na
Nitrobenzene	NA	2.09E+00		na	NA	1.51E+04		na
N-Nitrosopiperidine	NA	NV		na	NA	NA		na
Isophorone	NA	7.08E+00		na	NA	2.83E+04		na
2,4-Dimethylphenol	NA	7.30E+01		na	NA	NA		na
2-Nitrophenol	NA	NV		na	NA	NA		na

Table D-3: Comparison of Air Concentrations With Health-Based Values: Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare							
Compound	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
bis(2-Chloroethoxy)methane	NA	NV		na	NA	NA		na
Benzoic acid	NA	1.50E+04		na	NA	1.25E+04		na
2,4-Dichlorophenol	NA	1.10E+01		na	NA	3.00E+04		na
1,2,4-Trichlorobenzene	NA	NV		na	NA	3.71E+04		na
Naphthalene	3.30E-07	3.13E+00	1.06E-07	no	2.31E-03	7.86E+04	2.94E-08	no
p-Chloroaniline	NA	1.46E+01		na	NA	5.21E+03		na
2,6-Dichlorophenol	NA	NV		na	NA	3.00E+04		na
Hexachloropropene	NA	NV		na	NA	NA		na
Hexachlorobutadiene	NA	8.73E-02		na	NA	3.21E+04		na
Dimethylphenethylamine	NA	NV		na	NA	NA		na
N-Nitroso-di-n-butylamine	NA	1.20E-03		na	NA	NA		na
4-Chloro-3-methylphenol	NA	NV		na	NA	NA		na
Safrole	NA	NV		na	NA	NA		na
2-Methylnaphthalene	NA	NV		na	NA	2.00E+04		na
1,2,4,5-Tetrachlorobenzene	NA	1.10E+00		na	NA	3.00E+04		na
Hexachlorocyclopentadiene	NA	7.30E-02		na	NA	2.23E+02		na
2,4,6-Trichlorophenol	NA	6.20E-01		na	NA	3.00E+04		na
2,4,5-Trichlorophenol	NA	3.70E+02		na	NA	3.00E+04		na
Isosafrole	NA	NV		na	NA	NA		na
2-Chloronaphthalene	NA	2.90E+02		na	NA	6.00E+02		na
2-Nitroaniline	NA	2.10E-01		na	NA	NA		na
1,4-Naphthoquinone	NA	NV		na	NA	2.50E+02		na
Dimethylphthalate	NA	3.65E+04		na	NA	1.50E+04		na
1,3-Dinitrobenzene	NA	3.70E-01		na	NA	3.00E+03		na
2,6-Dinitrotoluene	NA	3.70E+00		na	NA	6.00E+02		na
Acenaphthylene	NA	NV		na	NA	2.00E+02		na
3-Nitroaniline	NA	NV		na	NA	NA		na
4-Nitrophenol	NA	2.90E+01		na	NA	3.00E+04		na
2,4-Dinitrophenol	NA	7.30E+00		na	NA	7.50E+03		na
Acenaphthene	NA	2.20E+02		na	NA	1.25E+03		na
2,4-Dinitrotoluene	NA	7.30E+00		na	NA	6.00E+02		na

Table D-3: Comparison of Air Concentrations With Health-Based Values: Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare							
Compound	$C_{chronic}$ (µg/m^3)	Health-Based Screening Level (µg/m^3)	$C_{chronic}$/ HBSL	> 1?	C_{acute} (µg/m^3)	Acute Toxicity Value (µg/m^3)	C_{acute}/ ATV	> 1?
Dibenzofuran	NA	1.46E+01		na	NA	1.50E+00		na
Pentachlorobenzene	NA	2.92E+00		na	NA	3.00E+04		na
1-Naphthylamine	NA	NV		na	NA	3.50E+04		na
2-Naphthylamine	NA	NV		na	NA	7.50E+03		na
2,3,4,6-Tetrachlorophenol	NA	1.10E+02		na	NA	NA		na
Diethylphthalate	NA	2.92E+03		na	NA	1.50E+04		na
4-Chlorophenylphenyl ether	NA	NV		na	NA	NA		na
Fluorene	NA	1.46E+02		na	NA	7.50E+04		na
5-Nitro-o-toluidine	NA	2.00E-01		na	NA	NA		na
4-Nitroaniline	NA	NV		na	NA	9.00E+03		na
4,6-Dinitro-2-methylphenol	NA	3.65E-01		na	NA	5.00E+02		na
Diphenylamine/N-NitrosoDPA	NA	NV		na	NA	2.50E+03		na
sym-Trinitrobenzene	NA	1.10E+02		na	NA	3.00E+04		na
Diallate	NA	1.10E-01		na	NA	NA		na
Phenacetin	NA	NV		na	NA	3.00E+04		na
4-Bromophenylphenyl ether	NA	NV		na	NA	NA		na
Hexachlorobenzene	NA	4.18E-03		na	NA	7.50E+01		na
4-Aminobiphenyl	NA	NV		na	NA	1.50E+03		na
Pronamide	NA	2.74E+02		na	NA	NA		na
Pentachlorophenol	NA	5.60E-02		na	NA	1.50E+03		na
Pentachloronitrobenzene	NA	2.59E-02		na	NA	1.50E+03		na
Phenanthrene	NA	NV		na	NA	2.00E+03		na
Anthracene	NA	1.10E+03		na	NA	6.00E+03		na
Carbazole	NA	3.36E-01		na	NA	NA		na
Di-n-butylphthalate	NA	3.65E+02		na	NA	1.50E+04		na
4-Nitroquinoline-1-oxide	NA	NV		na	NA	NA		na
Methapyrilene	NA	NV		na	NA	NA		na
Fluoranthene	NA	1.50E+02		na	NA	3.00E+01		na
Benzidine	NA	2.90E-05		na	NA	5.00E+02		na
Pyrene	NA	NV		na	NA	1.50E+04		na
p-Dimethylaminoazobenzene	NA	NV		na	NA	7.50E+04		na

Table D-3: Comparison of Air Concentrations With Health-Based Values: Semi-Volatile Organic Compounds

	Red Star Cluster Signal Flare							
Compound	$C_{chronic}$ ($\mu g/m^3$)	Health-Based Screening Level ($\mu g/m^3$)	$C_{chronic}$/ HBSL	> 1?	C_{acute} ($\mu g/m^3$)	Acute Toxicity Value ($\mu g/m^3$)	C_{acute}/ ATV	> 1?
Chlorobenzilate	NA	2.49E-02		na	NA	2.50E+02		na
Kepone	NA	3.74E-04		na	NA	1.00E+02		na
Butylbenzylphthalate	5.26E-07	7.30E+02	7.20E-10	no	3.68E-03	5.00E+05	7.37E-09	no
3,3'-Dimethylbenzidine	NA	7.30E-04		na	NA	3.00E+00		na
2-Acetylaminofluorene	NA	NV		na	NA	2.50E+03		na
bis(2-Ethylhexyl)phthalate	2.56E-07	4.80E-01	5.33E-07	no	4.18E-03	1.00E+04	4.18E-07	no
3,3'-Dichlorobenzidine	NA	1.50E-02		na	NA	6.21E+03		na
Benz(a)anthracene	NA	2.20E-02		na	NA	6.00E+02		na
Chrysene	NA	2.17E+00		na	NA	2.00E+02		na
Di-n-octylphthalate	2.26E-07	7.30E+01	3.09E-09	no	1.58E-03	1.50E+05	1.06E-08	no
7,12-Dimethylbenz(a)anthracene	NA	NV		na	NA	NA		na
Benzo(b)fluoranthene	NA	2.20E-02		na	NA	NA		na
Benzo(k)fluoranthene	NA	2.20E-01		na	NA	NA		na
Benz(a)pyrene	NA	2.20E-03		na	NA	7.50E+03		na
3-Methylcholanthrene	NA	NV		na	NA	1.50E+03		na
Indeno(1,2,3-cd)pyrene	NA	2.17E-02		na	NA	NA		na
Dibenz(a,h)anthracene	NA	2.17E-03		na	NA	3.00E+04		na
Benzo(g,h,i)perylene	NA	NV		na	NA	3.00E+04		na

Footnotes:
NA = Not applicable
na = Not available because health-based screening value is not available or not applicable because compound was not detected.
NV = No value
$C_{chronic}$ = Chronic time-averaged concentration
HBSL = Chronic health-based screening level
C_{acute} = Acute concentration
ATV = Acute toxicity value

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
TNMHC	NA	NA	NA	NA
Ethane	NA	NA	NA	NA
Ethylene	NA	NA	NA	NA
Acetylene	NA	NA	NA	NA
Propane	1.22E-06	NA	NA	NA
Propene	6.89E-06	NA	NA	NA
i-Butane	3.83E-08	NA	NA	NA
i-Butene	4.59E-07	NA	NA	NA
1-Butene	1.03E-06	NA	NA	NA
1,3-Butadiene	NA	NA	NA	NA
n-Butane	3.06E-07	NA	NA	NA
trans-2-Butene	8.80E-07	NA	NA	NA
2,2-Dimethylpropane	NA	NA	NA	NA
cis-2-Butene	3.44E-07	NA	NA	NA
3-Methyl-1-butene	NA	NA	NA	NA
i-Pentane	4.59E-07	NA	NA	NA
1-Pentene	3.83E-07	NA	NA	NA
2-Methyl-1-butene	2.68E-07	NA	NA	NA
n-Pentane	1.42E-06	NA	NA	NA
Isoprene	NA	NA	NA	NA
trans-2-Pentene	4.21E-07	NA	NA	NA
cis-2-Pentene	7.65E-08	NA	NA	NA
2-Methyl-2-butene	1.53E-07	NA	NA	NA
2,2-Dimethylbutane	NA	NA	NA	NA
Cyclopentene	7.65E-08	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
4-Methyl-1-pentene	NA	NA	NA	NA
Cyclopentane	NA	NA	NA	NA
2,3-Dimethylbutane	NA	NA	NA	NA
cis-4-Methyl-2-pentene	NA	NA	NA	NA
2-Methylpentane	1.91E-07	NA	NA	NA
3-Methylpentane	3.06E-07	NA	NA	NA
2-Methyl-1-pentene	NA	NA	NA	NA
1-Hexene	3.83E-07	NA	NA	NA
n-Hexane	1.91E-07	NA	NA	NA
trans-2-Hexene	NA	NA	NA	NA
2-Methyl-2-pentene	NA	NA	NA	NA
cis-2-Hexene	NA	NA	NA	NA
Methylcyclopentane	NA	NA	NA	NA
2,4-Dimethylpentane	NA	NA	NA	NA
Benzene	NA	NA	7.35E-06	NA
Cyclohexane	NA	NA	NA	NA
2-Methylhexane	7.65E-08	NA	NA	NA
2,3-Dimethylpentane	2.30E-07	NA	NA	NA
3-Methylhexane	0.00E+00	NA	NA	NA
2,2,4-Trimethylpentane	4.21E-07	NA	NA	NA
n-Heptane	NA	NA	NA	NA
2,4,4-Trimethyl-1-pentene	NA	NA	NA	NA
Methylcyclohexane	NA	NA	NA	NA
2,4,4-Trimethyl-2-pentene	NA	NA	NA	NA
2,5-Dimethylhexane	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	***Aliphatic:C>8***	***Aromatic:C<=8***	***Aromatic:C>8***
2,4-Dimethylhexane	NA	NA	NA	NA
2,3,4-Trimethylpentane	3.83E-08	NA	NA	NA
Toluene	NA	NA	2.64E-06	NA
2,3-Dimethylhexane	NA	NA	NA	NA
2-Methylheptane	NA	NA	NA	NA
3-Ethylhexane	NA	NA	NA	NA
2,2-Dimethylheptane	NA	NA	NA	NA
2,2,4-Trimethylhexane	NA	NA	NA	NA
n-Octane	1.53E-07	NA	NA	NA
Ethylcyclohexane	NA	NA	NA	NA
Ethylbenzene	NA	NA	1.03E-06	NA
m-Xylene & p-Xylene	NA	NA	2.83E-06	NA
Styrene	NA	NA	NA	7.65E-07
o-Xylene	NA	NA	9.57E-07	NA
n-Nonane	NA	9.18E-07	NA	NA
i-Propylbenzene	NA	NA	NA	NA
n-Propylbenzene	NA	NA	NA	3.83E-08
p-Ethyltoluene	NA	NA	NA	1.91E-07
m-Ethyltoluene	NA	NA	NA	3.83E-08
1,3,5-Trimethylbenzene	NA	NA	NA	7.65E-08
o-Ethyltoluene	NA	NA	NA	NA
1,2,4-Trimethylbenzene & sec-Butylbenzene	NA	NA	NA	1.15E-07
n-Decane	NA	NA	NA	NA
alpha-Pinene	NA	NA	NA	NA
beta-Pinene	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
delta 3-Carene	NA	NA	NA	NA
d-Limonene	NA	NA	NA	NA
MTBE	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	NA
Methylchloride	NA	NA	NA	NA
Dichlorotetrafluoroethane	NA	NA	NA	NA
Chloroethene	NA	NA	NA	NA
1,3-Butadiene	NA	NA	NA	NA
Methylbromide	NA	NA	NA	NA
Ethylchloride	NA	NA	NA	NA
Trichloromonofluoromethane	NA	NA	NA	NA
Vinylidenechloride	NA	NA	NA	NA
Methylenechloride	NA	NA	NA	NA
Allylchloride	NA	NA	NA	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA
1,2-Dichloroethene	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA
Methylchloroform	NA	NA	NA	NA
Benzene	NA	NA	7.47E-06	NA
Carbontetrachloride	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	NA	NA
Trichloroethylene	NA	NA	NA	NA
cis 1,3-Dichloro-1-propene	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	***Aliphatic:C>8***	***Aromatic:C<=8***	***Aromatic:C>8***
trans 1,3-Dichloro-1-propene	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA
Toluene	NA	NA	2.69E-06	NA
1,2-Dibromoethane	NA	NA	NA	NA
Perchloroethylene	NA	NA	NA	NA
Chlorobenzene	NA	NA	NA	NA
Ethylbenzene	NA	NA	1.59E-06	NA
m&p-Xylene	NA	NA	2.88E-06	NA
Styrene	NA	NA	NA	7.78E-07
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA
o-Xylene	NA	NA	9.73E-07	NA
p-Ethyltoluene	NA	NA	NA	1.95E-07
1,3,5-Trimethylbenzene	NA	NA	NA	NA
1,2,4-Trimethylbenzene	NA	NA	NA	1.17E-07
Benzylchloride	NA	NA	NA	NA
m-Dichlorobenzene	NA	NA	NA	NA
p-Dichlorobenzene	NA	NA	NA	NA
o-Dichlorobenzene	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA
o-Chlorotoluene	NA	NA	NA	NA
p-Chlorotoluene	NA	NA	NA	NA
1,3,5-Trichlorobenzene	NA	NA	NA	NA
1,2,3-Trichlorobenzene	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
Methylnitrite	NA	NA	NA	NA
Acetonitrile	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA
Nitromethane	NA	NA	NA	NA
Benzonitrile	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA
Carbonyl Sulfide	NA	NA	NA	NA
Sulfur Dioxide	NA	NA	NA	NA
Carbon Disulfide	NA	NA	NA	NA
Thiophene	NA	NA	NA	NA
Dimethyldisulfide	NA	NA	NA	NA
2-Methylthiophene	NA	NA	NA	NA
3-Methylthiophene	NA	NA	NA	NA
Dimethyltrisulfide	NA	NA	NA	NA
Isothiocyanatomethane	NA	NA	NA	NA
2-Chlorothiophene	NA	NA	NA	NA
3-Chlorothiophene	NA	NA	NA	NA
2-Thiophenecarboxaldehyde	NA	NA	NA	NA
Naphthalene	NA	NA	NA	7.84E-07
Acetaldehyde	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA
Acetone	NA	NA	NA	NA
Propanal	NA	NA	NA	NA
Furan	NA	NA	NA	NA
2-Propanol	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
2-Methylpropanal	NA	NA	NA	NA
Methacrolein	NA	NA	NA	NA
2,3-Butanedione	NA	NA	NA	NA
Methyl-Vinyl Ketone	NA	NA	NA	NA
MTBE	NA	NA	NA	NA
Butanal	NA	NA	NA	NA
2-Butanone	NA	NA	NA	NA
Tetrahydrofuran	NA	NA	NA	NA
2-Methyl-1-propanol	NA	NA	NA	NA
trans-2-Butenal	NA	NA	NA	NA
Acetic Acid	NA	NA	NA	NA
2-Pentanone	NA	NA	NA	NA
Pentanal	NA	NA	NA	NA
4-Methyl-2-pentanone	NA	NA	NA	NA
trans-2-Pentenal	NA	NA	NA	NA
Cyclopentanone	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA
Hexanal	NA	NA	NA	NA
3-Furaldehyde	NA	NA	NA	NA
Butyl Acetate	NA	NA	NA	NA
2-Furaldehyde	NA	NA	NA	NA
trans-2-Hexenal	NA	NA	NA	NA
1-Hexanol	NA	NA	NA	NA
3-Heptanone	NA	NA	NA	NA
2-Heptanone	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
Heptanal	NA	NA	NA	NA
trans-2-Heptenal	NA	NA	NA	NA
5-Methyl-2-furaldehyde	NA	NA	NA	NA
6-Methyl-2-heptanone	NA	NA	NA	NA
Benzaldehyde	NA	NA	NA	NA
1-Heptanol	NA	NA	NA	NA
6-Methyl-5-hepten-2-one	NA	NA	NA	NA
2-Octanone	NA	NA	NA	NA
Octanal	NA	NA	NA	NA
Benzofuran	NA	NA	NA	NA
trans-2-Octenal	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA
2-Nonanone	NA	NA	NA	NA
Nonanal	NA	NA	NA	NA
trans-2-Nonenal	NA	NA	NA	NA
2-Decanone	NA	NA	NA	NA
Decanal	NA	NA	NA	NA
N-Nitrosodimethylamine	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA
Methyl methanesulfonate	NA	NA	NA	NA
N-Nitrosomethylethylamine	NA	NA	NA	NA
N-Nitrosodiethylamine	NA	NA	NA	NA
Ethyl methanesulfonate	NA	NA	NA	NA
Phenol	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
Aniline	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA
Pentachloroethane	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA
bis(2-Chloroisopropyl)ether	NA	NA	NA	NA
o-Toluidine	NA	NA	NA	NA
4-Methylphenol/3-Methylphenol	NA	NA	NA	NA
N-Nitroso-di-n-propylamine	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA
N-Nitrosopyrrolidine	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

Compound (a)	Red Star Cluster Signal Flare			
	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
1,2,4-Trichlorobenzene	NA	NA	NA	NA
Naphthalene	NA	NA	NA	3.30E-07
p-Chloroaniline	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA
Dimethylphenethylamine	NA	NA	NA	NA
N-Nitroso-di-n-butylamine	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA
Safrole	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA
Dimethylphthalate	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
2,4-Dinitrophenol	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA
4-Chlorophenylphenyl ether	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA
5-Nitro-o-toluidine	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA
Diphenylamine/N-NitrosoDPA	NA	NA	NA	NA
sym-Trinitrobenzene	NA	NA	NA	NA
Diallate	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA
4-Bromophenylphenyl ether	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)	$C_{chronic}$ (µg/m^3)
	Aliphatic:C<=8	*Aliphatic:C>8*	*Aromatic:C<=8*	*Aromatic:C>8*
Anthracene	NA	NA	NA	NA
Carbazole	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA
4-Nitroquinoline-1-oxide	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA
Benzidine	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA
p-Dimethylaminoazobenzene	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA
Kepone	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA
Benz(a)anthracene	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA
7,12-Dimethylbenz(a)anthracene	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA
Benz(a)pyrene	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA

Table D-4: Comparison of Air Concentrations With Health-Based Values: Total Petroleum Hydrocarbons

	Red Star Cluster Signal Flare			
Compound (a)	**$C_{chronic}$ (µg/m^3)**	**$C_{chronic}$ (µg/m^3)**	**$C_{chronic}$ (µg/m^3)**	**$C_{chronic}$ (µg/m^3)**
	Aliphatic:C<=8	***Aliphatic:C>8***	***Aromatic:C<=8***	***Aromatic:C>8***
Dibenz(a,h)anthracene	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA
Total (µg/m^3)	1.64E-05	9.18E-07	1.56E-05	1.83E-06
Derived Health-Based Screening Level	1.92E+04	1.04E+03	4.17E+02	2.09E+02
$C_{chronic}$/HBSL	8.55E-10	8.81E-10	3.74E-08	8.78E-09
>1?	no	no	no	no

Footnotes:
(a) Items in bold represent duplicate values: highest concentration was used to estimate total petroleum hydrocarbon concentration
>1? = Is the ratio greater than one?
NA = Not Applicable because compound was not detected
$C_{chronic}$ = chronic averaged air Concentration
HBSL = Health-Based Screening Level

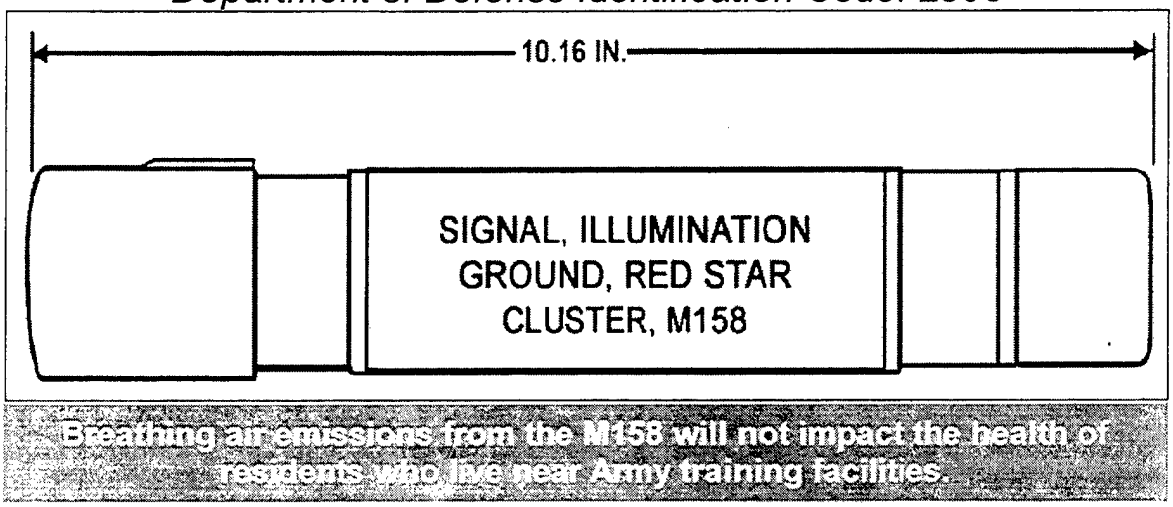
APPENDIX E

FACT SHEET SUBMITTED TO AEC

United States Army Environmental Center
Pyrotechnics Fact Sheet

M158 Red Star Cluster Signal Illumination

Department of Defense Identification Code: L306



Breathing air emissions from the M158 will not impact the health of residents who live near Army training facilities.

WHAT ARE PYROTECHNICS?

The terms pyrotechnics and fireworks are often used interchangeably. Pyrotechnics give off smoke, light, and/or a loud noise when activated. Military pyrotechnics are used for signaling, obscuring, and illuminating during training and combat.

WHAT IS THE M158?

The M158 is a star cluster, which is a type of pyrotechnic device consisting of a hand-held signal rocket. The M158 produces a cluster of five red-colored, free-falling stars. It is 10.16 inches long, 1.67 inches wide, and weighs 1.30 pounds.

HOW IS THE M158 USED?

The M158 is used for signaling and illuminating. A rocket containing the signal is launched from a hand-held device. After igniting, the rocket reaches a height of about 200 feet and produces a five-star illumination resembling a firework. The stars extend to a height between 650 and 800 feet (about the height of a 65 story building). Troops use the star cluster signals to communicate with one another. The light it provides can also be used for other purposes. For example, it can provide light for nighttime ground operations or it can be used to reveal an enemy's suspected hiding place.

WHERE IS THE M158 USED?

Many Army training events use the M158. These events are held at nearly every Army training installation. At most locations, the training areas are at least 1000 meters (over half a mile) away from populated areas. In general, one of these items is used during a day of training, which typically occurs five times a year.

WHAT IS IN THE M158?

The M158 consists of a rocket motor propulsion assembly contained in an aluminum launching tube. The illumination component consists primarily of strontium nitrate and magnesium powder. It also contains black powder, which is used in many commercial fireworks. Black powder consists mostly of potassium nitrate.

WILL BREATHING AIR EMISSIONS FROM THE M158 AFFECT MY HEALTH?

To answer this question, the U.S. Army Environmental Center tested the air emissions from the M158. The U.S. Army Center for Health Promotion and Preventive Medicine then determined if there would be a potential for health effects from inhalation to residents living near training areas. Study results showed that residents breathing air as close as 100 meters (328 feet) from the activation site are safe from these emissions.

HOW WAS THE STUDY DONE?

To gather data for the study, airborne emissions data was collected by activating the M158 in a test chamber. The air in the chamber was tested to identify the types and amounts of substances released. More than 300 substances were looked for during this part of the study.

This information was then used in an air model (a computer program that allows estimation of air concentrations) to determine the amount of each substance, to which someone living near a training site might be exposed. Downwind concentrations were estimated based on a typical use scenario for the M158. Since the study does not look at a specific training area, the assumptions used in the model will in most cases, predict higher downwind air concentrations than those expected at an actual training site.

These estimated air concentrations were compared to safe screening levels established by the U.S. Environmental Protection Agency and other agencies. If the air concentrations are below these screening levels, they are considered safe for everyone, including sensitive people such as the sick, elderly, and children.

WHAT ARE THE LIMITATIONS OF THIS STUDY?

Many steps were taken to ensure that the results of this study are protective of everyone who lives close to training areas. However, limitations do exist with this study. For example, the study does not consider exposure to other types of munitions that could also be used during the same training event. Due to these limitations, conservative model conditions were used to ensure the protection of public health from inhalation of the M158 air emissions.

WHERE CAN I GET MORE INFORMATION?

Additional information on the M158 and other military munitions can be obtained by calling the Army Environmental Center Hotline at 1-800-USA-3845 or email to t2hotline@aec. apgea.army.mil. Please also visit our website at www.aec.army.mil